Chapter 8
Science and Technology: Public Attitudes and Public Understanding

Contents

Highlights

Interest in—and Knowledge about—Science and Technology

- **In National Science Foundation (NSF) surveys conducted during the past two decades, about 9 out of every 10 U.S. adults report being very or moderately interested in new scientific discoveries and the use of new inventions and technologies.** Those with more years of formal education and those who have taken more courses in science and mathematics are more likely than others to express a high level of interest in science and technology.
- **The number of people who feel either well informed or moderately well informed about science and technology is fairly low.** In 1999, only 17 percent of those surveyed described themselves as well informed about new scientific discoveries and the use of new inventions and technologies; approximately 30 percent thought they were poorly informed.
- **Most Americans know a little, but not a lot, about science and technology.** Between 1997 and 1999, however, public understanding of basic science concepts and terms increased slightly.
- **Although there was little change in the late 1990s in the percentage of correct responses to most of the survey questions pertaining to knowledge of basic science concepts and terms, the percentage of correct responses to three items did increase.** More people are able to define a molecule, the Internet, and DNA. The growing awareness of DNA is probably attributable to heavy media coverage of the use of DNA in crime-solving and in advancements in the field of medicine.
- **About three-quarters of Americans lack a clear understanding of the nature of scientific inquiry.** Although more than one-half have some understanding of probability, only one-third were familiar with how an experiment is conducted and less than one-quarter could adequately explain what it means to study something scientifically.

Public Attitudes Toward Science and Technology

- **There seems to have been a small, upward trend in positive attitudes toward science and technology.** Overall, data from the NSF survey show increasing percentages of Americans *agreeing* that "science and technology are making our lives healthier, easier, and more comfortable" and *disagreeing* that "we depend too much on science and not enough on faith."
- **Although no detectable change occurred in overall public attitudes toward genetic engineering in the late 1990s, there was an increase in the number of individuals expressing reservations among (1) college graduates and (2) that portion of the public classified as attentive to new medical discoveries.** Among the former, the percentage who agreed that the harms of genetic engineering are greater than the benefits increased from 20 percent in 1995 to 29 percent in 1999. Among the latter group, the percentage rose from 30 percent in 1997 to 36 percent in 1999.

International Comparisons

- **North Americans and Europeans appear to have more favorable attitudes toward science and technology than the Japanese.** In addition, U.S. residents seem to harbor fewer reservations about science and technology than their counterparts in Europe, Canada, and Japan.
- **In North America, Europe, and Japan, university-educated citizens have the most positive attitudes toward science and technology, and the least reservations, whereas those who did not complete high school have the least favorable attitudes and the most reservations.** The inverse relationship between education and reservations about science and technology seems to be strongest in the United States, compared with three other sociopolitical systems.

Use of Computers and Computer Technology in the United States

- **In 1999, for the first time ever, a majority (54 percent) of American adults had at least one computer in their homes.** The percentage has been rising steadily since 1983, when only 8 percent had computers in their homes.
- **Approximately one-third of Americans subscribed to an online service and had home e-mail addresses in 1999.** Among those with access to the Internet, the amount of time spent using e-mail and visiting Web sites increased from an average of 80 hours per year in 1995 to approximately 270 hours in 1999.
- **The number of people without access to a computer either at home or at work fell substantially between 1983 and 1999—from 70 percent down to 34 percent.** However, more than 70 percent of those without high school diplomas did not have access to a computer either at home or at work in 1999.

The Relationship Between Science and the Media: Communicating with the Public

- **The science community and the news media are missing opportunities to communicate with each other and the public.** A recent study identified several problems including (1) scientists' distrust of the media, (2) a perceived lack of public interest in science, (3) communication barriers, and (4) the need for a better informed and educated public. Both scientists and the media could do a better job of communicating with the public so that taxpayers gain a better understanding of what they are getting from their investment in research and development (R&D).
- **Belief in paranormal phenomena, including astrology, extrasensory perception, and alien abductions, is fairly widespread.** Such beliefs may reflect a lack of scientific literacy or indicate a dearth of critical thinking skills needed not only to understand what is going on in the world, but also to make well-informed choices at the ballot box and in other day-to-day living activities. Depictions of paranormal activities in the entertainment media probably exacerbate the problem.

Introduction

Chapter Overview

Most Americans have highly positive attitudes toward science and technology. There is strong support for government investment in basic research, and Americans also appreciate technological advancements, especially rapidly expanding communication capabilities such as the Internet, which have permeated—and are having a pervasive impact on—an ever expanding number of daily living activities.

The news about science literacy is less positive. Americans do not seem to know much about science, especially the scientific process. Moreover, the prevalence of scientific illiteracy, or a dearth of critical thinking skills, may mean that many Americans are not adept at making, or adequately prepared to make, well-informed choices at the ballot box or in their personal lives.

Most Americans rely on television and newspapers as their major sources of information. Although the media can be commended for providing more access to more information than ever before, there is some concern that the press—with more cooperation from the science and engineering community—could do a better job of informing the public about science and technology and their contribution to economic prosperity, national security, and the health and well-being of society. In addition, the increase in information has led to "information pollution" or the presentation of fiction as fact in a growing number of television shows. The fact that many Americans are having trouble distinguishing between the two has caught the attention of the science—and science policy—community, where concern about the state of scientific literacy has never been higher. A technological society, one that is increasingly dependent on the intellectual capacity of its citizens, cannot afford to ignore ignorance.

Chapter Organization

This chapter begins with a discussion of the public's interest in, and knowledge about, science and technology. The level of interest in science and technology is an indicator of both the visibility of the science and engineering community's work and the relative importance accorded science and technology by society. The first section also contains data on the level of public understanding of basic science concepts and the nature of scientific inquiry and information on the level of interest and understanding in other countries.

In the second section, public attitudes toward science and technology are examined. Data on public attitudes toward Federal funding of scientific research and public confidence in the science community are included. In addition, this section contains information on public perceptions of the benefits and harms (or costs) of scientific research, nuclear power, genetic engineering, space exploration, and the use of animals in scientific research.

The third section is devoted to a discussion of computer usage, which is a relatively new way for the public to have access to information about science and technology. The fourth section covers findings from a recent study on science and the media. Finally, concerns about belief in paranormal phenomena are examined in the last section of this chapter.

Interest in—and Knowledge about—Science and Technology

Americans are quick to say they are interested in news about science and technology. In NSF surveys[1] conducted during the past two decades, about 9 of every 10 adults report being very or moderately interested in new scientific discoveries and the use of new inventions and technologies. However, the number who feel well—or moderately well—informed about these subjects is considerably smaller, and evidence shows their lack of confidence in their knowledge is justified. That is, most Americans know a little, but not a lot, about science and technology.[2]

In this section, four topics will be covered:

- public interest in science and technology and other issues,
- the public's self-assessed level of knowledge about science and technology and other issues,

[1]Thirteen of the 14 *Indicators* volumes published since 1972 have included a chapter on public attitudes toward and understanding of science and technology. The surveys for the 1972, 1974, and 1976 *Indicators* contained a block of 20 items inserted into an omnibus national personal interview survey conducted by Opinion Research Corporation of Princeton, New Jersey. The 1979 survey was designed by Miller and Prewitt (1979) and analyzed by Miller, Prewitt, and Pearson (1980); the personal interviews were conducted by the Institute for Survey Research at Temple University. Additional national surveys were undertaken for the 1982, 1985, 1987, 1991, and 1993 *Indicators* reports, with telephone interviews conducted by the Public Opinion Laboratory of Northern Illinois University. The chapter for *Science Indicators – 1985* was based on a national telephone survey conducted by the Public Opinion Laboratory for Professor George Gerbner of the Annenberg School of Communication at the University of Pennsylvania. In 1995, 1997, and 1999, the Chicago Academy of Sciences conducted surveys that continued the core of attitude and knowledge items from previous *Indicators* studies and included telephone interviews with a random-digit sample of 2,006 adults in 1995, 2,000 in 1997, and 1,882 in 1999. The interviews for the 1995 survey were conducted by the Public Affairs Division of Market Facts Incorporated. The interviews for the 1997 and 1999 surveys were conducted by the National Opinion Research Center. The results can be found in past volumes of *Indicators* (NSB biennial series).

In general, the response rate for each of the NSF surveys has been at 70 percent or higher. However, for the 1999 survey, the response rate was 66 percent. For more information on the 1999 survey methodology, see Miller, Kimmel, and Hess 2000.

[2]It is often suggested that people tend to respond to surveys by supplying what they think are "correct" or "expected" answers. For example, expressing interest in news stories about science and technology could be deemed a correct response. Although surveys (in addition to NSF's) have consistently shown high levels of interest in science and technology (Gannett 1996, Pew Research Center 1997), evidence that the average news consumer actually pays attention to reports covering these topics is lacking (Hartz and Chappell 1997). Research sponsored by the Pew Center for the People and the Press provides further insight leading to the conclusion that people may not be entirely truthful when responding to survey questions about their interests in various types of news subject. The study revealed that, although relatively few people claim to have interest in news stories about celebrities and scandal, their actual level of knowledge about these subjects is higher than that for any other news category (Parker and Deane 1997).

- the "attentive" public for science and technology policy, and
- public understanding of science and technology.

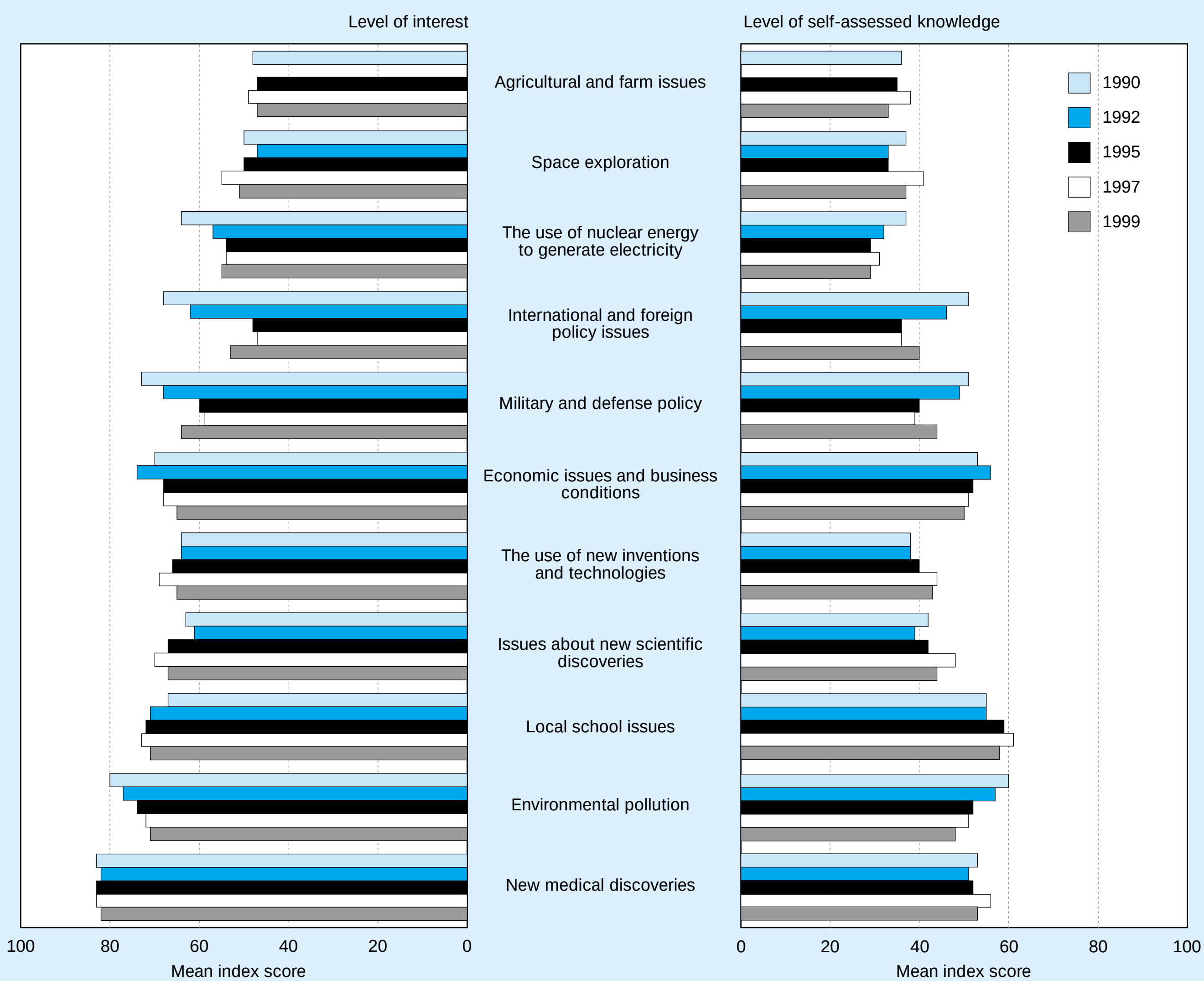
Public Interest in Science and Technology and Other Issues

U.S. residents say they are quite interested in science and technology. More than 40 percent of those who participated in NSF's 1999 Survey of Public Attitudes Toward and Understanding of Science and Technology said they were very interested in new scientific discoveries and in the use of new inventions and technologies; another 40 to 50 percent said they were moderately interested in these subjects; and about 10 percent reported no interest. (See appendix table 8-1.) Among the 11 topics included in the survey, only the level of interest in new medical discoveries, environmental pollution, and local school issues appears higher. (See figure 8-1.)

Approximately two-thirds of the respondents said they were very interested in new medical discoveries. None of the other policy issues received anywhere near such a high percentage of "very interested" responses.[3] Local school issues was a

[3]Surveys sponsored by Research!America show overwhelming public support for medical research. It is not a coincidence that the high level of support—coupled with the high level of interest in new medical discoveries—coincides with historically strong Federal financial support of research sponsored by the National Institutes of Health (NIH) (Hartz and Chappell 1997). (See chapter 2, " U.S. and International Research and Development: Funds and Alliances.") Interestingly, NIH has relatively little name recognition; less than 5 percent of the public can name the government agency that funds most of the medical research paid for by taxpayers. In contrast, 57 percent can name the National Aeronautics and Space Administration (NASA), and 70 percent can name the Food and Drug Administration (Research!America 1999).

Figure 8-1.
Indices of public interest in and self-assessed knowledge about scientific and technological issues: 1990–99



See appendix tables 8-2 and 8-5.

Science & Engineering Indicators – 2000

distant second, with 54 percent of the respondents saying they were very interested in this topic, followed by environmental pollution at 51 percent. (See appendix table 8-1.)

Issues receiving between 40 and 50 percent "very interested" responses were new scientific discoveries (45 percent), military and defense policy (42 percent), economic issues and business conditions (42 percent), and the use of new inventions and technologies (41 percent). Percentages for the other four issues ranged from 30 percent for international and foreign policy to 22 percent for agricultural and farm issues. Interest in space exploration is relatively low; it ranked next to last among the 11 issues.[4] (See appendix table 8-1.)

Interest in science and technology may be at its highest level ever. Using a 0–100 index,[5] the average level of public interest in new scientific discoveries ranged between 67 and 70 in the late 1990s; only in one other year (1983) did it reach that level, although it has always been at 60 or higher. Interest in new inventions and technologies tracks quite closely with that of new scientific discoveries; in 1999, the index levels for the two issues were 65 and 67, respectively. (See figure 8-2 and appendix table 8-2.)

New medical discoveries is the only issue that has consistently had index scores in the 80s; those for environmental pollution and local school issues have generally been in the 70s. Interest in environmental pollution seems to have subsided slightly in the 1990s. (See appendix table 8-2.)

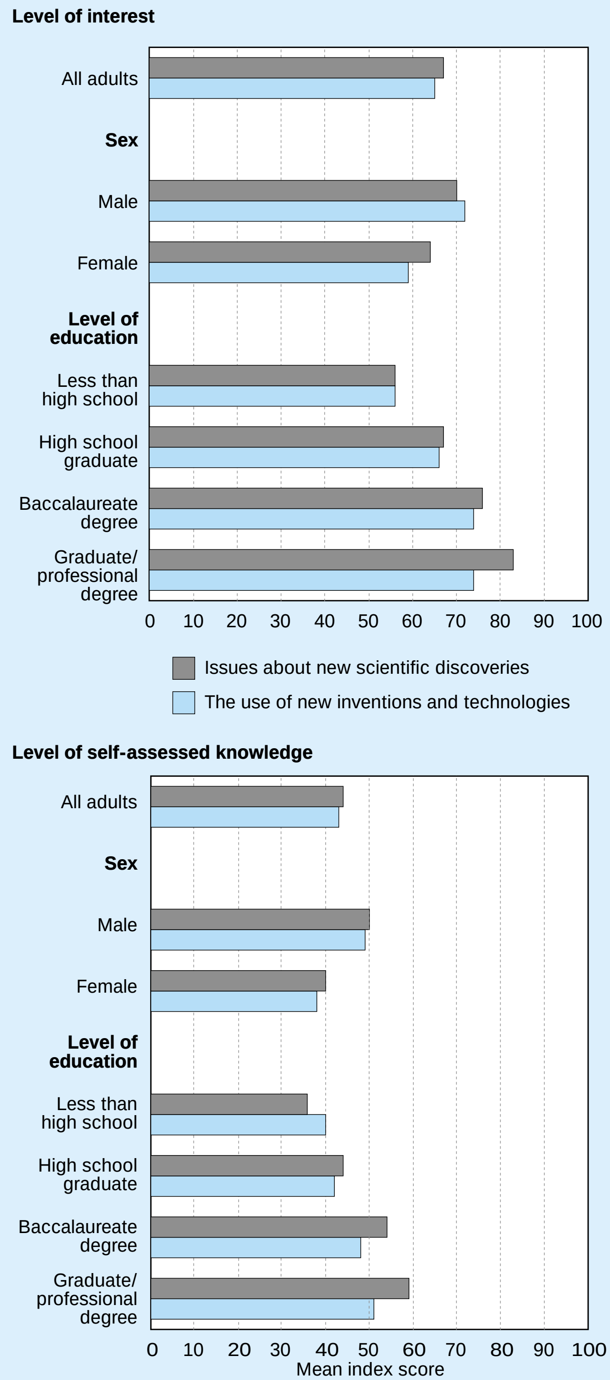
Among the other survey findings:

- Interest in economic issues and business conditions has dipped somewhat since 1992, when it ranked third among the 11 issues in the survey. The decline in interest may be attributable to the health of the U.S. economy in the mid- and late 1990s.
- Interest in military and defense policy and in international and foreign policy reached a peak in 1990 (coinciding with the pending Gulf War at the time the survey was conducted). Interest in international and foreign policy took an upward swing between 1997 and 1999, from 47 to 53, which may reflect heightened interest stemming from the war in the Balkans.
- Interest in the use of nuclear energy to generate electricity fell from 64 in 1990 to 54 in 1995; little change in the level of interest occurred in the late 1990s. (See appendix table 8-2.)

[4]An earlier survey produced results mirroring those of NSF's: 43 percent of that survey's respondents said they were very interested in learning more about science discoveries in general, and 45 percent said they were very interested in learning more about new inventions. In addition, 67 percent reported being very interested in learning more about advances in medicine. In contrast, only 32 percent had this level of interest in learning more about space exploration (Roper 1996).

[5]Responses were converted to a 0–100 scale by assigning a value of 100 for a "very interested" response, a value of 50 for a "moderately interested" response, and a value of 0 for a "not at all interested" response. Indices were obtained by adding all the values for each issue and taking the average.

Figure 8-2.
Indices of public interest in and self-assessed knowledge about scientific and technological issues, by sex and level of education: 1999



See appendix tables 8-3 and 8-6.

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Comparing Interest by Sex and Level of Education

Men express more interest than women in new scientific discoveries and in the use of new inventions and technologies. (See figure 8-2.) The gap is particularly large for the latter. Only space exploration has a larger disparity. Men also express more interest than women in economic and business conditions, military and defense policy, international and foreign policy, and nuclear energy. Women are more interested in new medical discoveries, environmental pollution, and local school issues. (See appendix table 8-3.)

Level of formal education and number of mathematics and science courses taken are strongly associated with interest in new scientific discoveries. (See figure 8-2 and appendix table 8-3.) The relationship between education and level of interest is also strong for space exploration, economic issues and business conditions, and for international and foreign policy—and somewhat less strong for the use of new inventions and technologies and new medical discoveries. Local school issues, the use of nuclear energy to generate electricity, and environmental pollution do not seem to show a relationship between level of interest and level of education. Finally, those with relatively low levels of formal education are more likely than others to express high interest in agricultural and farm issues. (See appendix table 8-3.)

International Comparisons

In general, a substantial amount of similarity exists between U.S. residents and those in three other "sociopolitical systems,"[6] in terms of interest in particular public policy issues.[7] For example, for all four—the United States, the European Union, Japan, and Canada—the Index of Issue Interest in environmental issues is in the low to middle 70s. However, survey respondents in the United States and Canada seem to have higher levels of interest in health and medical issues than their counterparts in Europe and Japan. (See text table 8-1.)

Americans are somewhat more interested than Europeans in new scientific discoveries and in new inventions and technologies, whereas Europeans are slightly more interested than Americans in environmental issues.

The Japanese appear to be less interested than Europeans or North Americans in science and technology. In general, Japanese adults express relatively more interest in economic matters and local issues—for example, land use—than in new scientific discoveries and the use of new inventions and technologies. A significantly higher percentage of college-educated respondents in Japan (compared with the percentage of those with less formal education) reported substantial interest in scientific and technological issues, which is also the case in Europe and in North America (Miller, Pardo, and Niwa 1997).

[6]The term "sociopolitical systems" is used because data for Europe were collected with one survey, the 1992 Eurobarometer. Residents of 11 countries participated in this survey. Those countries are Belgium, Denmark, England, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, and Spain.

[7]The international information in this chapter comes from a comparative analysis of data from the following sources: the 1992 Eurobarometer, the 1995 NSF Survey of Public Understanding of and Attitudes Toward Science and Technology, the 1991 Japan National Study, and the 1989 Canadian National Study (Miller, Pardo, and Niwa 1997).

Text table 8-1.
Issue interest index scores for the European Union, the United States, Japan, and Canada

Issue	Mean scores			
	European Union (1992)	United States (1995)	Japan (1991)	Canada (1989)
New scientific discoveries	61	67	50	63
New inventions and technologies	59	66	53	58
New medical discoveries	68	83	65	77
Environmental issues	75	74	71	74
Space exploration	–	50	45	48
Energy/nuclear power	–	54	59	–
Computers and related technologies	–	–	–	43
Economic policy	–	68	65	52
Education/local schools	–	72	62	–
Agricultural issues	–	47	56	–
Military/defense issues	–	60	56	–
Foreign & international policy	–	48	55	–
Politics	55	–	–	50
Sports news	48	–	–	42
Taxes	–	–	71	–
Land use issues	–	–	65	–
Senior citizen issues	–	–	74	–

– = Issue not included in the survey

SOURCE: J.D. Miller, R. Pardo, and F. Niwa, *Public Perceptions of Science and Technology: A Comparative Study of the European Union, the United States, Japan, and Canada* (Chicago: Chicago Academy of Sciences,1997).

Science & Engineering Indicators – 2000

The Public's Self-Assessed Level of Knowledge about Science and Technology and Other Issues

In general, Americans do not believe they are well informed about issues pertaining to science and technology. In fact, for all issues included in the NSF survey, the level of self-assessed knowledge appears considerably lower than the level of expressed interest. This is especially true for complex subjects, like science and technology, where a lack of confidence in understanding what goes on in laboratories or within the policymaking process is understandable. For example, in 1999, at least 40 percent of respondents in NSF's public attitudes survey said they were very interested in science and technology. Yet only 17 percent described themselves as well informed about new scientific discoveries and the use of new inventions and technologies; approximately 30 percent thought they were poorly informed. (See appendix table 8-4.)

Thus, index scores for the responses to the questions having to do with how well informed people think they are about various issues were lower than those for the level of interest in those same issues. (See figure 8-1.) In 1999, three had index scores in the 50s (local school issues, new medical discoveries, and economic issues and business conditions); five, in the 40s (environmental pollution, new scientific discoveries, military and defense policy, the use of new inventions and technologies, and international and foreign policy); and three, in the 20s or 30s (space exploration, agricultural and farm issues, and the use of nuclear energy to generate electricity). (See appendix table 8-5.)

In the 1990s, for most issues, there were no discernible trends in the level of self-assessed knowledge. However, there seems to have been a decline in perceived knowledge about environmental pollution and the use of nuclear energy to generate electricity. (See appendix table 8-5.)

Level of Self-Assessed Knowledge, by Sex and Level of Education

For 8 of the 11 issues in the 1999 survey, male respondents reported higher self-assessment of their knowledge than female respondents. For five of these issues—economic issues and business conditions, military and defense policy, the use of new inventions and technologies, international and foreign policy, and space exploration—the gender gap is more than 10 index points. (See appendix table 8-6.)

In contrast, women have higher index scores than men on two issues—local school issues and new medical discoveries—but the disparity in scores between the two sexes is relatively small. For environmental pollution, the index scores were identical in 1999.

As expected, generally, the more education one has—and the more mathematics and science courses one has taken—the better informed one thinks he or she is. The relationship between education and self-assessed knowledge is particularly strong for new scientific discoveries, the use of new inventions and technologies, and space exploration. It is also strong for economic issues and business conditions and for international and foreign policy issues, but weak or nonexistent for the other issues in the survey. (See appendix table 8-6.)

The "Attentive" Public for Science and Technology Policy

No one has the time or the inclination to keep up with every issue on the public policy agenda. Moreover, not many people are interested in many issues. A recent study contained the following conclusion:

> An analysis of public attentiveness to more than 500 news stories over the last 10 years confirm[ed] that the American public pays relatively little attention to many of the serious news stories of the day. The major exceptions to this rule are stories dealing with natural and man-made disasters and U.S. military actions[8] (Parker and Deane 1997).

Also, different people will be interested in, and will be well informed about, different issues. Some are interested in particular issues that affect their daily lives. For example, parents of school-age children are more likely than others to show interest in issues having to do with the quality of schools in their communities. Chances are these parents are not only interested in, but well-informed about, local school issues. Others are just interested in particular issues, and because of their interest, they have taken the time to become knowledgeable about them; they probably also follow public policy developments in their areas of interest.

It may not be easy to pinpoint exactly who is the audience for issues pertaining to science and technology policy. It is probably safe to say that members of the science and engineering workforce, especially those in the academic community, are probably interested in, and well informed about, various science and technology policy issues, but the number of members in this community is relatively small. (See chapter 3, "Science & Engineering Workforce," and chapter 6, "Academic Research and Development: Financial and Personnel Resources, Support for Graduate Education, and Outputs.") In addition, other members of the public follow news reports about new scientific discoveries and new inventions and technologies. It is interesting to single out the audience for science and technology policy so that their attitudes and knowledge can be compared with those of everyone else.

Therefore, it is useful to classify the public into three groups:

- ♦ The attentive public: Those who (1) express a high level of interest in a particular issue, (2) feel well-informed about that issue, and (3) read a newspaper on a daily basis, read

[8]The most closely followed news stories from 1986 through the middle of 1999 were identified by the Pew Research Center for People and the Press. In all, there were 689 such stories. Only 39 can be considered to have anything to do with science or technology, a small proportion (less than 6 percent) of the total. Most of those have to do with weather and earthquake coverage, lending credence to the truism that stories about natural and made disasters are more likely than others to grab the public's attention. It should be noted that a science-related story is at the top of the list: the most closely watched story of the period was the explosion of the Space Shuttle Challenger in 1986. (See sidebar, "The Most Closely Followed Science-Related News Stories: 1986–99.")

The Most Closely Followed Science-Related News Stories: 1986–99

For nearly 15 years, the Pew Research Center for the People and the Press (1999b) has been tracking the most closely followed news stories in the United States. Out of 689 stories identified by the Center during the period, 39 have at least some relevance to science and medicine. Those stories, and the month and year the public was surveyed (which is a good indication of when the event occurred), are listed below. Next to each entry is the percentage of those surveyed who said they were following the story "very closely" (the other choices given to respondents were "fairly closely," "not too closely," or "not at all closely").

Weather is the subject of 12 of the stories on the list; they are clustered toward the top. Ten stories involve coverage of space exploration, including the lead story of the period studied, the explosion of the Space Shuttle Challenger. Four news stories are about earthquakes and the damage they cause. Two are about problems at nuclear reactor plants. Health is the subject of six stories, and three are about efforts to clone animals and people.

80%	Explosion of the Space Shuttle Challenger (July 1986)
73%	Destruction caused by the San Francisco earthquake (November 1989)
66%	Hurricane Andrew (September 1992)
65%	The floods in the Midwest (August 1993)
63%	Earthquake in Southern California (January 1994)
51%	News about cold weather in the Northeast and Midwest (January 1994)
50%	Flight of the Space Shuttle (October 1988)
49%	Drought and its effects on American farmers (August 1988)
48%	The blizzard on the East Coast (January 1996)
46%	Nuclear accident at Chernobyl in the Soviet Union (July 1986)
42%	Hot weather this summer and the greenhouse effect (August 1988)
39%	Unseasonable weather patterns (December 1998)
38%	The heat wave and its impact throughout the country (July 1998)
37%	The floods in California (March 1995)
36%	Hurricane Mitch and the rain and mudslides in Central America (November 1998)
34%	John Glenn's flight on the Space Shuttle Discovery (November 1998)
34%	Floods in the Pacific Northwest (January 1997)
34%	Reports about flooding in Texas and other southwestern states (June 1990)
28%	Problems at nuclear reactor plants (October 1988)
25%	The earthquake in Japan (February 1995)
24%	The breast implant controversy (February 1992)
24%	Deployment of the Hubble Space Telescope (May 1990)
23%	The controversy over whether women in their forties should have regular mammograms (February 1997)
22%	The exploration of the Planet Mars by the Pathfinder Spacecraft (August 1997)
22%	Discoveries made by the spacecraft Voyager 2 (September 1989)
21%	Plans by a Chicago scientist to open a clinic for cloning people (January 1998)
20%	Earthquake in Iran (July 1990)
19%	The outbreak of an Asian flu spread by birds or chickens (January 1998)
17%	The cloning of a sheep by a Scottish biologist (April 1997)
15%	The new drug Viagra designed to help men overcome impotence (June 1998)
15%	The problems aboard the Russian Space Station Mir (September 1997)
14%	The problems aboard the Russian Space Station Mir (August 1997)
11%	The return of Space Shuttle astronaut Shannon Lucid to Earth (October 1996)
11%	The outbreak of plague in India (October 1994)
9%	The debate over U.S. policy concerning global warming (November 1997)
9%	Discovery of scientific evidence of the beginnings of the universe (May 1992)
9%	AIDS conference in San Francisco (July 1990)
8%	NASA's discovery of possible life on Mars (September 1996)
6%	The cloning of mice by scientists in Hawaii (July 1998)

a weekly or monthly news magazine, or read a magazine relevant to the issue.[9]

- The interested public: Those who claim to have a high level of interest in a particular issue, but do not feel well informed about it.
- The residual public: Those who are neither interested in, nor feel well-informed about, a particular issue.

There is an attentive public for every policy issue; these groups differ in size and composition.

Data for 1999 show that, for most issues covered by the NSF survey, less than 10 percent of the public can be considered attentive. New medical discoveries has the largest audience: 16 percent of all survey respondents in 1999 were classified as attentive to that subject. (See appendix table 8-7.)

Those likely to be attentive to science and technology policy issues are identified by combining the attentive public for new scientific discoveries with the attentive public for new inventions and technologies. In 1999, 12 percent of the population qualified for that distinction, down from 14 percent in 1997. Forty-four percent of the population can be classified as the "interested public" for science and technology issues with the "residual" population also at 44 percent of the total. (See appendix table 8-7.)

The Attentive Public for Science and Technology Policy, by Sex and Level of Education

A direct correlation exists between attentiveness to science and technology policy issues, years of formal education, and the number of science and mathematics courses taken during high school and college. In 1999, only 9 percent of people without high school diplomas were classified as attentive to science and technology policy issues, compared with 23 percent of those with graduate and/or professional degrees. Similarly, 9 percent of those with limited coursework in science and mathematics were attentive to science and technology policy issues, compared with 19 percent of those who had taken nine or more high school and college science or math courses. Men were more likely than women to be attentive to science and technology policy issues. (See figure 8-3 and appendix table 8-8.)

International Comparisons

In the United States, Europe, and Canada, approximately 1 in 10 adults can be classified as attentive to science and technology policy; the proportion is smaller—about 7 percent—in Japan. The percentage classified as the "interested" public (for science and technology policy) is higher in the United States than it is in the other three sociopolitical systems. In 1995, it was 47 percent, compared with 33 percent in Europe (for 1992), 40 percent in Canada (1989), and 12 percent in Japan (1991). For all countries, there is a positive relationship between level of education and level of attentiveness (Miller, Pardo, and Niwa 1997). (See text table 8-2.)

[9]For a general discussion of the concept of issue attentiveness, see Miller, Pardo, and Niwa (1997).

Public Understanding of Science and Technology

Science literacy in the United States (and in other countries) is fairly low. That is, the majority of the general public knows a little, but not a lot, about science and technology. For example, most Americans know that the Earth goes around the Sun and that light travels faster than sound. However, not many can successfully define a molecule, and few have a good understanding of what the Internet is despite the fact that the Information Superhighway has occupied front page headlines throughout the late 1990s—and usage has skyrocketed. (See the section "Use of Computers and Computer Technology in the United States" and chapter 9, "Significance of Information Technologies.") In addition, most Americans have little comprehension of the nature of scientific inquiry.

It is important to have some knowledge of basic scientific facts, concepts, and vocabulary. Those who possess such knowledge have an easier time following news reports and participating in public discourse on various issues pertaining to science and technology. It may be even more important to have an appreciation for the scientific process. Understanding how ideas are investigated and analyzed is a sure sign of scientific literacy. This knowledge is valuable not only in keeping up with important issues and participating in the political process, but also in evaluating and assessing the validity of various other types of information.

In NSF's Survey of Public Attitudes Toward and Understanding of Science and Technology, respondents are asked a series of questions designed to assess their knowledge and understanding of basic science concepts and terms. There are 20 such questions, 13 of which are true/false, 3 are multiple choice, and 4 are open-ended; that is, respondents are asked to define in their own words DNA, a molecule, the Internet, and radiation. In addition, respondents are asked questions designed to test their understanding of the scientific process, including their knowledge of what it means to study something scientifically, how experiments are conducted, and probability.

Understanding Terms and Concepts

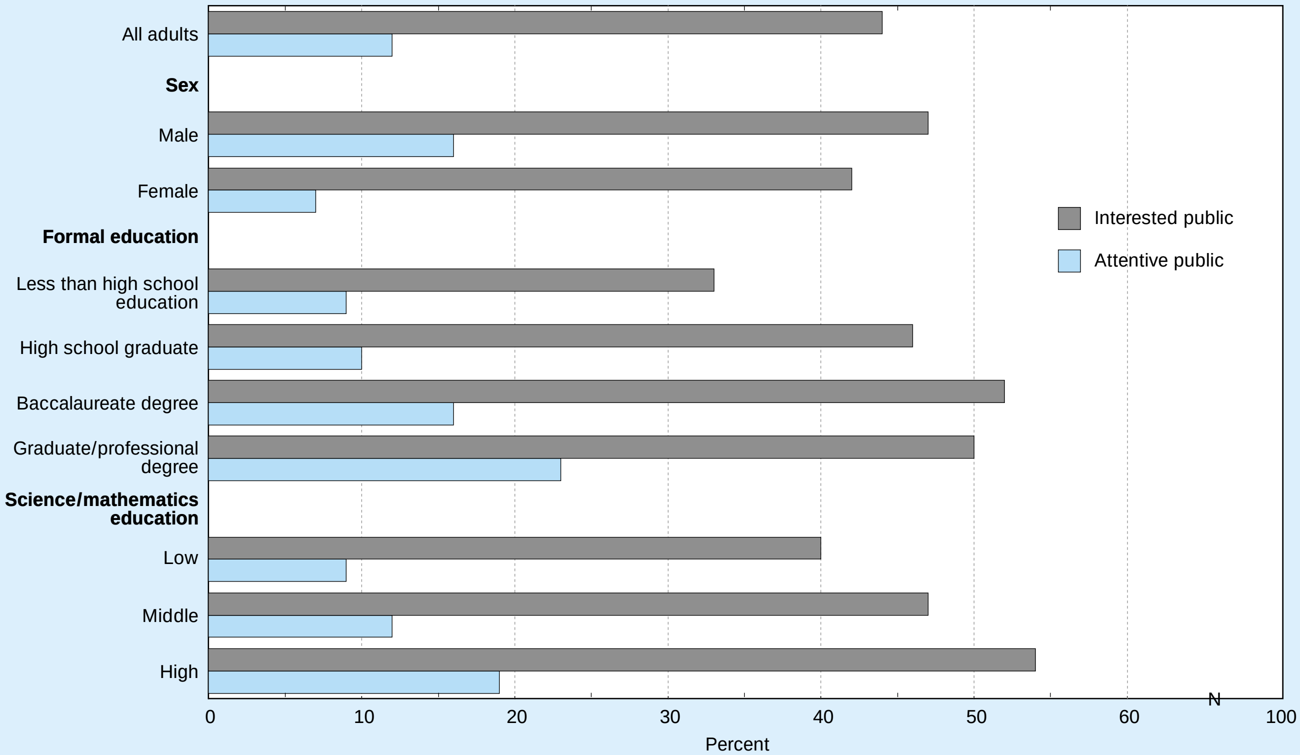
The percentage of correct responses to most of the questions pertaining to respondents' knowledge of basic science concepts and terms was fairly constant in the late 1990s. For example, more than 70 percent of those interviewed knew that:

- Oxygen comes from plants.
- The continents have been moving for millions of years and will continue to move in the future.
- Light travels faster than sound.
- The Earth goes around the Sun (and not vice versa).
- All radioactivity is not man-made. (See appendix table 8-9.)

In contrast, about one-half or fewer of the respondents knew that:

- The earliest humans did not live at the same time as dinosaurs.

Figure 8-3.
Public attentiveness to science and technology: 1999



NOTES: The "attentive" public are people who (1) express a high level of interest in a particular issue, (2) feel well informed about that issue, and (3) read a newspaper on a daily basis, read a weekly or monthly news magazine, or frequently read a magazine highly relevant to the issue. The "interested" public are people who express a high level of interest in a particular issue but don't feel well informed about it. The attentive public for science and technology is a combination of the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Anyone who is not attentive to either of these issues, but who is a member of the interested public for at least one of these issues, is classified as a member of the interested public for science and technology. Survey respondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college math/science courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

See appendix table 8-8. *Science & Engineering Indicators – 2000*

Text table 8-2.
Percentage of adults attentive to, or interested in, science and technology

	European Union (1992)		United States (1995)		Japan (1991)		Canada (1989)	
Variable	AP	IP	AP	IP	AP	IP	AP	IP
All adults	10	33	10	47	7	12	11	40
Education								
Less than high school	5	25	4	37	1	8	9	37
High school graduate	9	33	8	48	7	13	11	45
Baccalaureate degree	18	40	21	53	14	15	19	46
Sex								
Male	13	36	12	49	12	15	14	44
Female	7	30	8	45	2	10	7	47
Civic scientific literacy								
Well informed	18	45	29	55	40	26	26	42
Moderately well informed	14	39	14	51	12	21	16	44
Not well informed	7	27	7	45	4	9	8	40
Number of cases	1,226	3,971	195	946	101	177	209	809

AP = attentive public; IP = interested public

SOURCE: J.D. Miller, R. Pardo, and F. Niwa, *Public Perceptions of Science and Technology: A Comparative Study of the European Union, the United States, Japan, and Canada* (Chicago: Chicago Academy of Sciences,1997). *Science & Engineering Indicators – 2000*

- It takes the Earth one year to go around the Sun.
- Electrons are smaller than atoms.
- Antibiotics do not kill viruses.[10]
- Lasers do not work by focusing sound waves. (See appendix table 8-9.)

In addition, few respondents (11 percent) were able to define radiation, the Internet (16 percent), a molecule (13 percent), and DNA (29 percent). Although the percentage of correct responses to these questions is considerably lower than that for the short-answer questions, it is noteworthy that the percentage of correct responses to three of these questions increased in the late 1990s:

- In 1995, only 9 percent of respondents could successfully define a molecule. That percentage rose to 11 percent in 1997 and to 13 percent in 1999.
- In 1999, 29 percent of the respondents could define DNA, up from 21 percent in 1995 and 22 percent in 1997. Undoubtedly, this growing awareness of DNA is attributable to heavy media coverage of the use of DNA in crime-solving and in advancements in the field of medicine. (See figure 8-4.)
- The percentage of those able to define the Internet increased from 13 percent in 1997 to 16 percent in 1999.

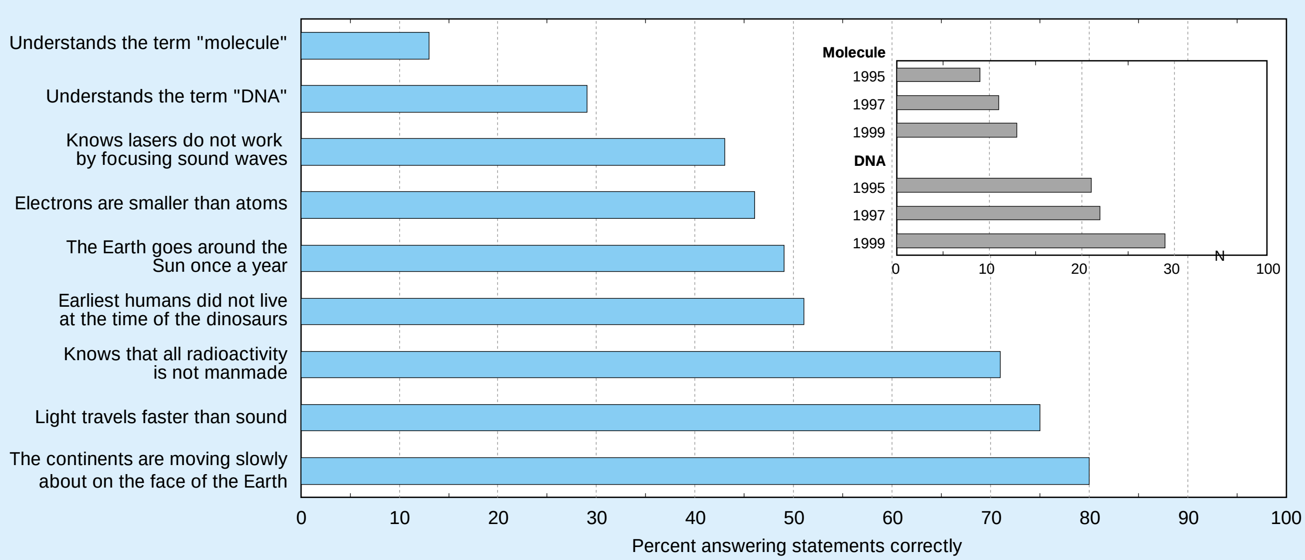
These survey questions have been used to develop an Index of Scientific Construct Understanding, making it possible to track the level of knowledge in the United States over time and to compare that level with the level in other countries.[11] Nine of the survey items are included in this index; they are listed in figure 8-4.[12] The mean score for American adults on the Index of Scientific Construct Understanding was 58. The comparable scores for 1995 and 1997 were 55 for both years. Understanding of basic science concepts and terms is strongly related to both the level of formal education and the number of high school and college science and mathematics courses taken. The mean scores for college graduates and those with graduate or professional degrees were 74 and 80, respectively, compared with 44 for individuals who did

[10]The growing resistance of bacteria to antibiotics has received widespread media coverage in the past few years. In identifying the main cause of the problem—the over-prescribing of antibiotics—it is mentioned that antibiotics are ineffective in killing viruses. Despite the media coverage, more than half of those surveyed answered "true" to the statement "Antibiotics kill viruses as well as bacteria." Although the percentage of those answering false went up slightly—from 40 percent in 1995 to 45 percent in 1999—the lack of correct responses indicates a lack of communication with the public on this health-related issue.

[11]Although comparable data for other countries have not been updated since the early 1990s, the most recent information available indicates similar scores for the United States, Denmark, the Netherlands, and Great Britain. All have slightly higher scores than France and Germany. For a complete discussion of these data, see chapter 7 in *Science & Engineering Indicators – 1998* (NSB 1998).

[12]The items included in the Index of Scientific Construct Understanding were first identified by confirmatory factor analysis. So that these items could be placed on a common metric applicable to studies in the United States and to studies conducted in other countries, a set of item-response theory (IRT) values was computed for each item, which takes into account the relative difficulty of each item and the number of items used in each study. This technique has been used by the Educational Testing Service and other national testing organizations in tests such as the Test of English as a Foreign Language, the computer-based versions of the Graduate Record Examination, and the National Assessment of Educational Progress. The original IRT score for each respondent is computed with a mean of 0 and a standard deviation of 1, which means that half the respondents would have a negative score. So that more understandable terms could be used, the original IRT score was converted to a 0–100 scale.

Figure 8-4.
Public understanding of scientific terms and concepts: 1999



See appendix table 8-9. *Science & Engineering Indicators – 2000*

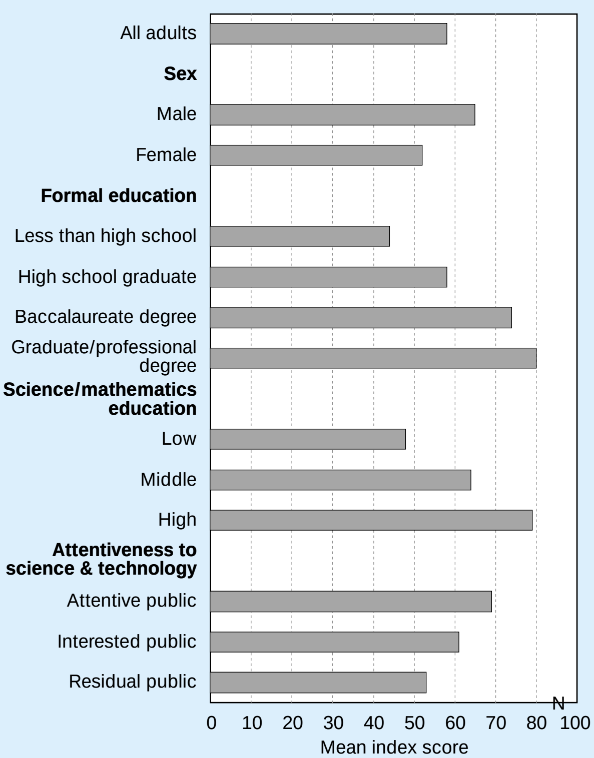
not complete high school. Those who completed nine or more high school and college science or math courses had a mean score of 79, compared with 48 for adults who had taken five or fewer courses. Men scored significantly higher than women, with a mean score of 65 compared with 52 for women. (See figure 8-5 and appendix table 8-10.)

Two of the true/false survey questions (not included in the Index of Scientific Construct Understanding) have relatively low percentages of correct responses:

- About one-third of the respondents answered "true" to the statement, "The universe began with a huge explosion."
- Forty-five percent answered "true" to the statement, "Human beings, as we know them today, developed from earlier species of animals." (See appendix table 8-9.)

Responses to these two questions may reflect religious beliefs rather than actual knowledge about science. For the last three-quarters of the century, probably the most controversial topic in science teaching has to do with how evolution is taught—or not taught—in U.S. classrooms. In late 1999, states taking opposite sides of the issue received a considerable amount of publicity in the news media. In Kansas and Kentucky, the teaching of evolution was dropped as a required part of the curriculum.[13] (The National Science Board issued a statement in August 1999 on the Kansas action; see NSB 1999.) In contrast, New Mexico's board of education adopted an "evolution only" policy. For a more comprehensive discussion of curriculum content at the precollege level, see chapter 5, "Elementary and Secondary Education."

Figure 8-5.
Mean score on Index of Scientific Construct Understanding, by sex, level of education, and attentiveness to science and technology: 1999



See appendix table 8-10. *Science & Engineering Indicators – 2000*

Understanding of Scientific Inquiry

To find out how well the public understands the nature of scientific inquiry, NSF asked survey respondents a series of questions. First, they were asked to explain what it means to study something scientifically.[14] In addition, respondents were asked questions pertaining to the experimental evaluation of a drug[15] and to determine their understanding of probability.[16]

In the 1999 survey, 21 percent of the respondents provided good explanations of what it means to study something scientifically.[17] About one-third answered the experiment questions correctly, including being able to say why it was better to use a control group. More than half (55 percent) of the respondents answered the four probability questions correctly. (See appendix table 8-11.)

The level of understanding of the nature of scientific inquiry is estimated using a combination of each survey participant's responses to the questions. To be classified as understanding the nature of scientific inquiry, a respondent had to answer all the probability questions correctly *and* either provide a "theory-testing" response to the question about what it means to study something scientifically or provide a correct response to the open-ended question about the ex-

[13]In an October 1999 poll, sponsored by the *Kansas City Star* and the *Wichita Eagle*, 52 percent of the respondents disagreed with the state board of education's decision; 57 percent agreed with the statement that "students in science classes in public schools should study and be tested on the idea of evolution, the theory that living creatures have common ancestors and have changed over time."

[14]The question was, "When you read news stories, you see certain sets of words and terms. We are interested in how many people recognize certain kinds of terms, and I would like to ask you a few brief questions in that regard. First, some articles refer to the results of a scientific study. When you read or hear the term scientific study, do you have a clear understanding of what it means, a general sense of what it means, or little understanding of what it means?" If the response is "clear understanding" or "general sense": "In your own words, could you tell me what it means to study something scientifically?"

[15]The question was, "Now, please think of this situation. Two scientists want to know if a certain drug is effective in treating high blood pressure. The first scientist wants to give the drug to 1,000 people with high blood pressure and see how many experience lower blood pressure levels. The second scientist wants to give the drug to 500 people with high blood pressure, and not give the drug to another 500 people with high blood pressure, and see how many in both groups experience lower blood pressure levels. Which is the better way to test this drug? Why is it better to test the drug this way?"

[16]The text of the probability question was, "Now think about this situation. A doctor tells a couple that their 'genetic makeup' means that they've got one in four chances of having a child with an inherited illness. Does this mean that if their first three children are healthy, the fourth will have the illness? Does this mean that if their first child has the illness, the next three will not? Does this mean that each of the couple's children will have the same risk of suffering from the illness? Does this mean that if they have only three children, none will have the illness?"

[17]A correct understanding of scientific study includes responses describing scientific study as theory testing, experimentation, or rigorous, systematic comparison.

periment, i.e., explain why it was better to test a drug using a control group. In 1999, 26 percent of the survey respondents gave responses that met these criteria. (See figure 8-6 and appendix table 8-11.) In 1995 and 1997, the comparable percentages were 21 percent and 27 percent, respectively.

Public Attitudes Toward Science and Technology

In general, Americans express highly favorable attitudes toward science and technology. In the 1999 NSF public attitudes survey, overwhelming majorities agreed—and few disagreed—with the following statements:

- ◆ Science and technology are making our lives healthier, easier, and more comfortable (90 percent agreed and 9 percent disagreed).
- ◆ Most scientists want to work on things that will make life better for the average person (83 percent agreed and 15 percent disagreed).
- ◆ With the application of science and technology, work will become more interesting (73 percent agreed and 23 percent disagreed).
- ◆ Because of science and technology, there will be more opportunities for the next generation (84 percent agreed and 14 percent disagreed). (See appendix table 8-12.)

In a 1996 survey,

- ◆ Nearly half the respondents said that the terminology that best describes their reaction to science and technology was "satisfaction or hope"; 36 percent chose "excitement or wonder"; and only 6 percent answered "fear or alarm."
- ◆ More than half the respondents said that new developments in science and technology will have a positive impact on the overall standard of living in the United States; one-fifth thought the impact would be negative.
- ◆ Approximately four out of five respondents agreed that encouraging the brightest young people to go into scientific careers should be a top national priority (Roper 1996).

Despite these indicators, a sizeable portion—although not a majority—of the public has some reservations concerning science and (especially) technology. See sidebar, "Attitudes of Scientists, Legislators, and the Public Toward Science and Technology." For example, in the 1999 NSF survey, half of those queried agreed with the statement: "We depend too much on science and not enough on faith" (45 percent disagreed). And, about 40 percent agreed that "science makes our way of life change too fast" (57 percent disagreed). (See appendix table 8-12.)

Overall, however, there seems to have been a small, upward trend in positive attitudes toward science and technology. In general, data from the NSF survey show increasing percentages of Americans

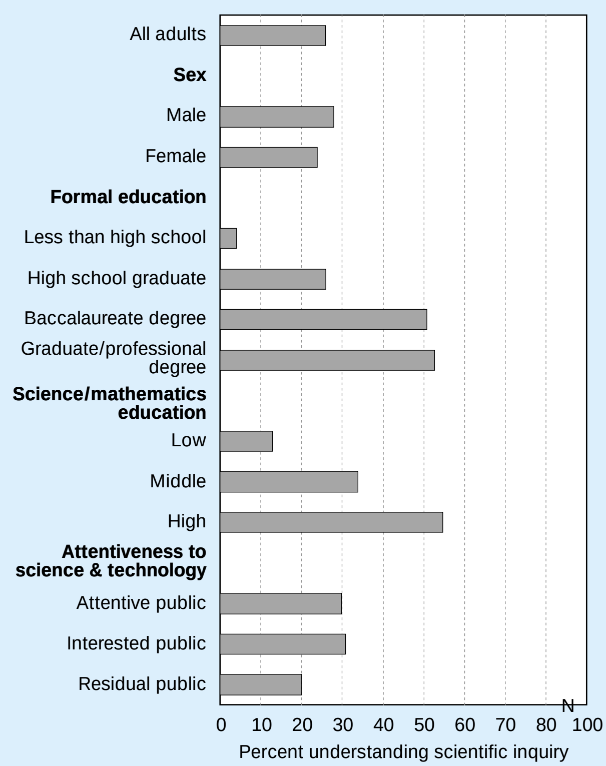
- ◆ *agreeing* that "science and technology are making our lives healthier, easier, and more comfortable" and
- ◆ *disagreeing* that "we depend too much on science and not enough on faith." (See appendix table 8-13.)

In addition, the survey results indicate that an increasing number of people believe that the benefits of scientific research outweigh any harmful results. (See the section "Perceptions of Scientific Research.")

The concern that does exist appears to be related to the impact of technology on society. For example, NSF survey respondents were fairly evenly split about whether "computers and factory automation will create more jobs than they will eliminate." (See appendix table 8-14.) And, a sizeable minority—46 percent—agreed with the statement that "people would do better by living a simpler life without so much technology." (See appendix table 8-15.) Also, about 3 out of every 10 people surveyed agreed that "technological discoveries will eventually destroy the Earth" and that "technological development creates an artificial and inhumane way of living." (See appendix tables 8-16 and 8-17.)

In a 1999 survey, more than half the respondents (55 percent) agreed with the statement, "Our growing reliance on technology is generally good because it makes life more convenient and easier." However, 39 percent of the respondents

Figure 8-6.
Public understanding of the nature of scientific inquiry: 1999



See appendix table 8-11. *Science & Engineering Indicators – 2000*

Attitudes of Scientists, Legislators, and the Public Toward Science and Technology

In a 1998 survey, researchers at the University of New Mexico Institute for Public Policy queried randomly selected individuals representing three groups—working scientists, members of state legislatures, and the general public—to find out their perspectives on nuclear security.* Included in the survey were several questions having to do with attitudes toward science and technology. Not unexpectedly, the scientists held more positive attitudes than members of the other two groups. For example, 83 percent of the scientists agreed that "science is the best source of reliable knowledge about the world"; about two-thirds of the legislators and members of the public also agreed with that statement. Responses to a question related to technology, however, showed a real difference of opinion. Forty percent of the respondents representing the general public agreed with the statement that "technology has become dangerous and unmanageable," compared with only 13 percent of the scientists and 15 percent of the legislators. (See figure 8-7.)

Responses to other questions revealed a general consensus among members of the three groups: slightly more than half the scientists and members of the public agreed that "science can eventually explain anything"; just under 50 percent of the legislators chose that response. Also, slightly more than half of each group disagreed with the statement "technology can solve most of society's problems."

Two questions exposed very different attitudes toward the process of scientific inquiry: A majority of the public and approximately half the legislators agreed with the following statements:

- ♦ The same scientific evidence can almost always be interpreted to fit opposing points of view.
- ♦ The results of scientific research will almost always be significantly affected by the values held by the researcher.

In contrast, only 22 percent of the scientists agreed with the first statement, and 36 percent with the second.

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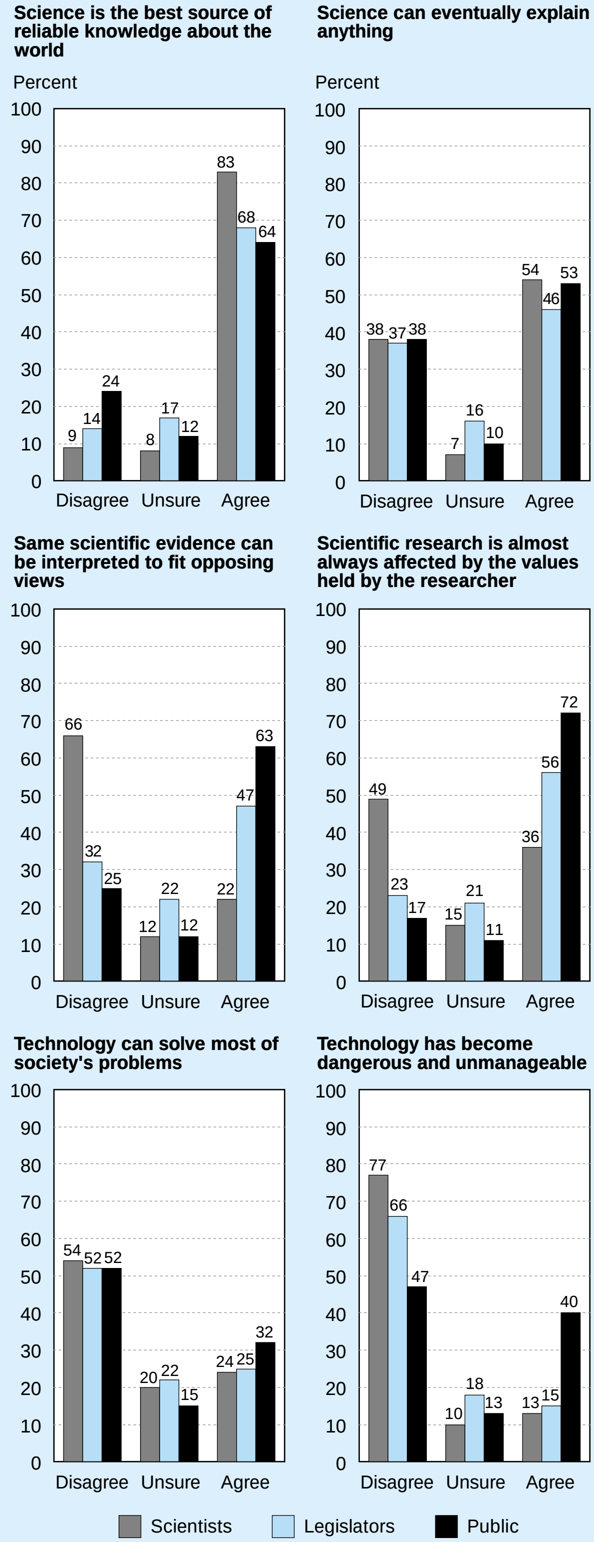
*The response rates for the general public, the scientists, and the legislators were 54.8 percent, 53.8 percent, and 21.7 percent, respectively. Because the response rate for the legislators was less than half that of the other two groups, extensive nonresponse analysis was conducted. A comparison of views between legislator respondents and nonrespondents showed a significant difference on three survey questions. Data from those questions are not included in this sidebar. For more information on the nonresponse analysis, see Herron and Jenkins-Smith (1998).

Figure 8-7.
Attitudes of scientists, legislators, and the public toward science and technology: 1997



SOURCE: K.G. Hebron and H.C. Jenkins-Smith, *Public Perspectives on Nuclear Security* (Albuquerque, New Mexico: The University of New Mexico Institute for Public Policy, 1998), pp. 210–11, 213.

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agreed with the other choice, "Our growing reliance on technology is generally bad because we will become too dependent on it and life will get too complicated." Those with higher incomes are more likely to have positive attitudes toward technology: 73 percent of the respondents reporting at least $75,000 in annual income chose the first statement, compared with only 46 percent of those reporting less than $20,000 (The Pew Research Center 1999a).

In another survey, more than half the respondents agreed that "science and technology [have] caused some of the problems we face as a society" (13 percent answered "most" of the problems). Responses to another question in the same survey were more positive: when asked to describe their "reaction when [they acquire] a new technical gadget, like a VCR…," nearly three out of five chose the response, "excitement at discovering what it can do"; another quarter of those surveyed picked "hope it will let you do things more easily." Only 6 percent feared they would not be able to use the new device, and 9 percent chose "indifference or lack of interest" (Roper 1996).

The Promise of Science—and Reservations

To track trends in public attitudes toward science and technology and to compare attitudes in the United States with those in other countries, an Index of Scientific Promise and an Index of Scientific Reservations were developed. In addition, the ratio of the Promise Index to the Reservations Index is a useful indicator of current and changing attitudes toward science and technology.[18]

Although a strong positive relationship exists between a person's level of education and favorable attitudes toward science and technology, both the Index of Scientific Promise and the Index of Scientific Reservations have remained fairly stable since 1992. However, it is noteworthy that the overall ratio of Promise to Reservations rose from 1.74 in 1995 to 1.89 in 1997. In 1999, the ratio was 1.87. (See appendix table 8-18.)

International Comparisons

North Americans and Europeans appear to have more favorable attitudes toward science and technology than the Japanese. At 55, Japan's mean score on the Index of Scientific Promise was considerably lower than that for the United States, the European Union, and Canada, all of which have scores close to 70. In all four sociopolitical systems, university-educated citizens have the most positive attitudes toward science and technology, whereas those who did not complete high school have less favorable attitudes. (See text table 8-3.)

U.S. residents seem to harbor fewer reservations about science and technology than their counterparts in the other three sociopolitical systems. The European Union, Japan, and Canada have similar Index of Scientific Reservations mean scores—all in the upper 50s—whereas the U.S. score was in the upper 30s.

In all four sociopolitical systems, individuals with the lowest levels of formal education expressed the highest levels of reservation about science and technology. The inverse relationship between education and reservations about science seems to be strongest in the United States. In addition, those who scored highest on measures of science literacy reported significantly lower levels of reservation about science and technology than those with less knowledge of science.

In all four societies, women were slightly more likely than men to hold reservations about science and technology. The disparities were small and may be attributable to differences in educational achievement.

Public Attitudes Toward the Funding of Scientific Research by the Federal Government

All indicators point to widespread support for government funding of basic research. In the 1999 NSF survey, 82 percent of those queried agreed with the following statement:

> Even if it brings no immediate benefits, scientific research that advances the frontiers of knowledge is necessary and should be supported by the Federal Government.

Moreover, the level of agreement has been rising—and the level of disagreement falling—since 1992. (See appendix table 8-19.) During the mid-1990s, a gender gap in support for federally funded basic research seemed to be closing. In 1999, 84 percent of the men in the survey agreed with the statement cited above, compared with 80 percent of the women. (See appendix table 8-19.)

Support for federally funded basic research is closely tied to education level. In other words, the level of support rises with the level of formal education. In 1999, 72 percent of those surveyed who had not completed high school agreed with the statement; that percentage rose to 84 percent for high school graduates, to 87 percent for those with college degrees, and to 91 percent for those with graduate or professional degrees. (See appendix table 8-19.)

In addition, those with more positive overall attitudes toward science and technology were more likely to express support for government funding of basic research. In 1999, 90 percent of those who scored 75 or higher on the Index of Scientific Promise agreed that the Federal Government should fund basic scientific research, compared with only 61 per-

[18]The Index of Scientific Promise and the Index of Scientific Reservations are factor scores converted to a 0–100 scale. For each of the four countries or regions, a separate confirmatory factor analysis verified the existence of a two factor structure, and factor scores were computed for each dimension for each country or region. Within each country or region, the lowest possible factor score (strong disagreement with all of the items) was set to zero, and the highest possible factor score (strong agreement with all of the items) was set to 100. All factor scores between the highest and the lowest were placed on the 0–100 metric accordingly.

A core of items was identical in all countries and regions, and there was some minor variation in wording for some items from country to country. The strength of this factor analytic approach is that it allows the calibration of complete disagreement and complete agreement as end points on a 0–100 scale and creates a metric that is comparable across countries and regions. The questions used in the United States are described in the notes for appendix table 8-18; the questions used in Canada, Europe, and Japan are described in Miller, Pardo, and Niwa (1997).

cent of those with relatively low index scores. (See figure 8-8 and appendix table 8-20.)

Other studies have revealed similar favorable attitudes toward the government's role in supporting science and technology. In one survey, more than 80 percent of the respondents agreed that "the Federal Government has an important role to play in encouraging new developments in science and technology" and that "it is important that the United States be the world leader in technological progress" (Roper 1996). (See sidebar, "Americans Give High Marks to Government Investment in R&D.")

Only 14 percent of those who participated in the NSF survey thought the government was spending too much on scientific research; 37 percent thought the government was not spending enough. To put the response to this item in perspective, at least 65 percent of those surveyed thought the government was not spending enough on other programs, including reducing pollution, improving health care, improving educa-

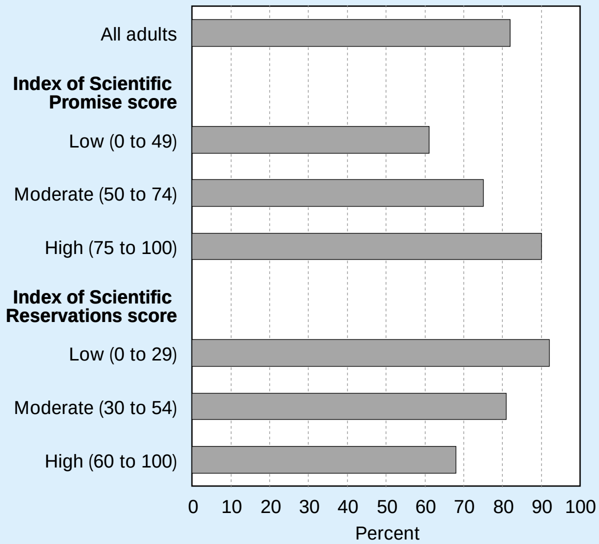
Text table 8-3.
Index of Scientific Promise and Index of Scientific Reservations for the European Union, the United States, Japan, and Canada

Variable	Mean scores: European Union (1992)	Mean scores: United States (1995)	Mean scores: Japan (1991)	Mean scores: Canada (1989)
Scientific Promise				
All adults	69	68	55	72
Level of formal education				
Less than high school	68	63	54	68
High school graduate	69	68	55	75
Baccalaureate degree	71	71	56	84
Sex				
Male	70	69	55	76
Female	68	67	54	68
Civic scientific literacy				
Well informed	70	72	64	84
Moderately well informed	69	69	58	80
Not well informed	79	67	54	69
Attentiveness to science and technology policy				
Attentive public	74	74	56	79
Interested public	72	69	59	74
Residual public	67	65	54	69
Number of cases	6,122	2,006	1,457	2,000
Scientific Reservations				
All adults	58	39	56	56
Level of formal education				
Less than high school	64	51	62	60
High school graduate	57	39	55	52
Baccalaureate degree	53	27	50	40
Sex				
Male	57	38	55	53
Female	60	40	57	58
Civic scientific literacy				
Well informed	46	24	45	39
Moderately well informed	55	30	55	45
Not well informed	62	42	56	59
Attentiveness to science and technology policy				
Attentive public	57	30	54	45
Interested public	57	38	52	54
Residual public	60	42	57	59
Number of cases	6,122	2,006	1,457	2,000

SOURCE: J.D. Miller, R. Pardo, and F. Niwa, *Public Perceptions of Science and Technology: A Comparative Study of the European Union, the United States, Japan, and Canada* (Chicago: Chicago Academy of Sciences,1997).

Science & Engineering Indicators – 2000

Figure 8-8.
Support for government funding of basic scientific research, by level of general support for or reservations about science and technology: 1999



See appendix table 8-20. *Science & Engineering Indicators – 2000*

tion, and helping older people. In the survey, only exploring space and improving national defense had less support for increased spending than scientific research.[19] In fact, 46 percent of the respondents thought spending on space exploration was excessive, a higher percentage than that for any other item in the survey. (See appendix tables 8-21 and 8-22 and the section "Perceptions of Space Exploration.") It should be noted that few respondents really know what the government spends on various programs.[20]

International Comparisons

Government support for basic scientific research is at least as popular in Europe, Japan, and Canada as it is in the United States. In all four sociopolitical systems, the level of support has been about 80 percent or higher; the highest levels seem to be in Canada and Japan. (See text table 8-4.) In all four societies,

- The level of formal education and the level of scientific literacy were positively associated with support for government funding of basic scientific research.

Americans Give High Marks to Government Investment in R&D

Participants in a series of focus groups commissioned by several high-technology companies expressed strong support for government funding of R&D.* The consensus was that R&D should be considered a priority investment in the future quality of life and that R&D expenditures should not be cut to balance the budget (Public Opinion Strategies and Luntz Research and Strategic Services 1996).

Comments heard at sessions include:

- "Japan and Europe are investing heavily in 21st-century technology. If we don't keep pace, we'll be left behind."
- "If a technology is economically critical, the government should support R&D in that area."
- "Technological innovation doesn't just happen; we have to invest in it."
- "R&D keeps us militarily strong."

Although the focus group participants expressed support for strengthening government investment in both basic research and applied research, if they had to choose among competing priorities, they would give more emphasis to applied research projects because of their potential for leading to tangible payoffs in the more immediate future. According to the participants, government-funded R&D projects should:

- be a national priority,
- have potential benefit for a broad number of people,
- improve people's lives, and
- have a favorable cost–benefit calculation.

*The focus groups were held in 1996 in Lancaster, Pennsylvania (April 11), Columbus, Ohio (April 17), Houston, Texas (April 24), and New Orleans, Louisiana (April 25). The participants were selected for their awareness of current events and their interest in politics; they had a somewhat higher income and education level than the public at large and represented both political parties.

- Those who expressed greater interest in science and technology were more supportive than those with less interest in those subjects.
- Men were slightly more likely than women to support government spending on basic scientific research.

Public Confidence in the People Running Various Institutions

Public confidence in the leadership of various institutions has been tracked for nearly a quarter of a century (Davis and Smith annual series). Participants in the General Social Sur-

[19]Another poll also did not find high levels of support for increased science research funding (Wirthlin 1995).

[20]As an aside, in the First Amendment Center survey of journalists and scientists (see the section "The Relationship Between Science and the Media: Communicating with the Public"), respondents were asked what percentage of the total Federal budget is devoted to scientific research and technology development. The four choices were less than 1 percent, 1 percent to 10 percent, 11 percent to 20 percent, and more than 20 percent. Half the journalists and 65 percent of the scientists chose the correct response [1 percent to 10 percent; the actual figure is 4 percent (See chapter 2). Most of the rest of the survey participants guessed that less than 1 percent of the Federal budget is invested in science and technology.

Text table 8-4.
Approval of government support for basic scientific and technological research

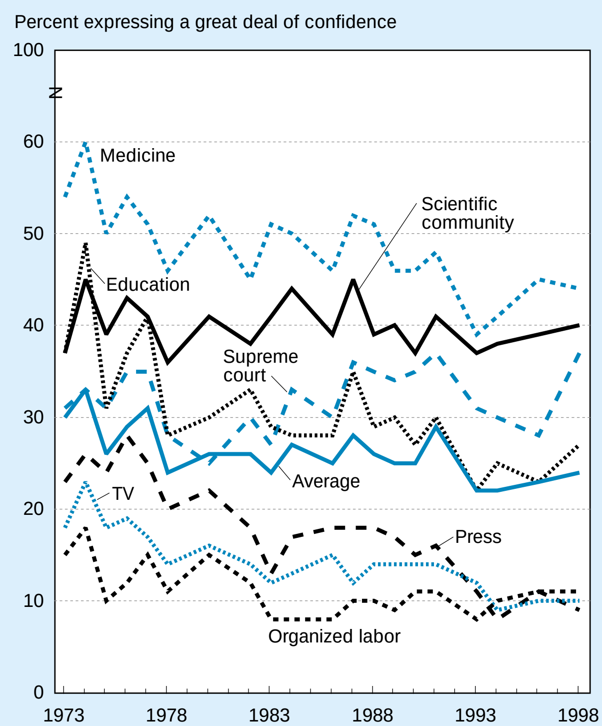
Variable	European Union (1992)	United States (1995)	Japan (1991)	Canada (1989)
	Percentage strongly agreeing or agreeing			
All adults	80	78	86	88
Level of formal education				
Less than high school	67	67	81	85
High school graduate	83	79	86	89
Baccalaureate degree	89	87	93	98
Sex				
Male	83	79	90	91
Female	77	77	83	84
Civic scientific literacy				
Well informed	91	90	96	98
Moderately well informed	87	87	94	93
Not well informed	74	75	85	86
Attentiveness to science and technology policy				
Attentive public	91	83	89	92
Interested public	89	85	96	90
Residual public	73	70	84	84
Number of cases	6,122	2,006	1,457	2,000

SOURCE: J.D. Miller, R. Pardo, and F. Niwa, *Public Perceptions of Science and Technology: A Comparative Study of the European Union, the United States, Japan, and Canada* (Chicago: Chicago Academy of Sciences,1997). *Science & Engineering Indicators – 2000*

vey were asked whether they have a "great deal of confidence, only some confidence, or hardly any confidence at all" in the leadership of various institutions. In 1998, 40 percent reported that they had a great deal of confidence in the leadership of the scientific community. The only category that exceeded this vote of confidence was the medical community. Science has held the number two spot exclusively since 1978, overtaking education (for the last time) in that year. The Supreme Court, the military, education, major companies, and organized religion filled out the next five spots in 1999. The public has the least confidence in the press and TV; the "great deal of confidence" vote for the leadership of these institutions was 10 percent or less in 1998. (See figure 8-9 and appendix table 8-23.)

Interestingly, although the vote of confidence for the scientific community has fluctuated somewhat during the past quarter-century, it has remained about 40 percent. In contrast, there seems to have been an erosion in confidence in the medical profession. The rating for this group was once as high as 60 percent (1974); that percentage has been gradually declining for most of the past 25 years.

Figure 8-9.
Public confidence in leadership of selected institutions: 1973–98



See appendix table 8-23. *Science & Engineering Indicators – 2000*

Perceptions of Scientific Research

By an overwhelming majority, Americans consistently believe that the benefits of scientific research outweigh any harmful results. Nearly half (47 percent) of the survey respondents said that the benefits *strongly* outweigh the harms, and another 27 percent said they *slightly* outweigh the harms. These percentages have been fairly stable for the past two decades, as has the percentage of respondents taking the opposite position. That is, between 10 and 20 percent of those queried believe the harms outweigh the benefits. (See figure 8-10 and appendix table 8-24.)

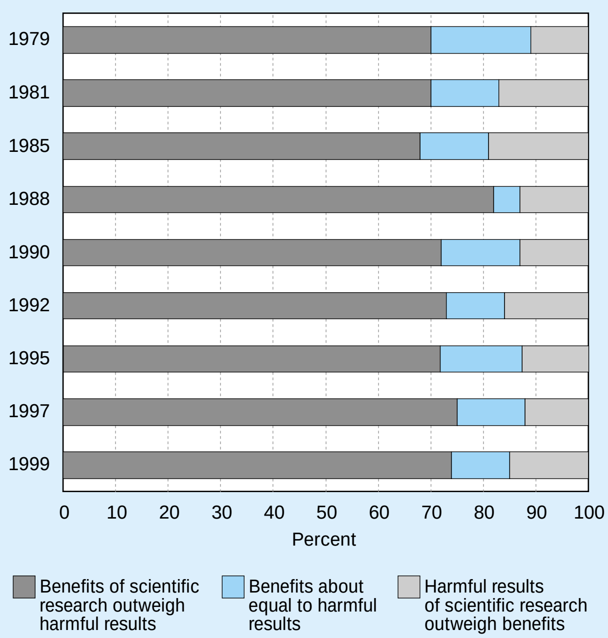
Men express greater surety than women that the benefits of scientific research outweigh the harmful results. In fact, 50 percent of the men in the 1999 survey, compared with 45 percent of the women, said that the benefits *strongly* outweighed the harms. Level of education is also strongly associated with a positive response to this question. Those who did not complete high school are more likely than those with more formal education to believe the harms outweigh the benefits, although it should be noted that half of this group said the benefits outweigh the harms. The comparable percentages for high school graduates and for those with at least a bachelor's degree were 78 percent and 90 percent, respectively, in 1999. (See appendix table 8-24.)

Perceptions of Nuclear Power

Americans are not as positive about all science and technology issues as they are about scientific research in general. For example, they have been evenly divided for more than a decade over the use of nuclear power to generate electricity. In 1999, 48 percent of Americans believed the benefits of nuclear power outweighed the harms, while 37 percent held the opposite view, and 15 percent thought that benefits and harms were equal. (See figure 8-11 and appendix table 8-25.)

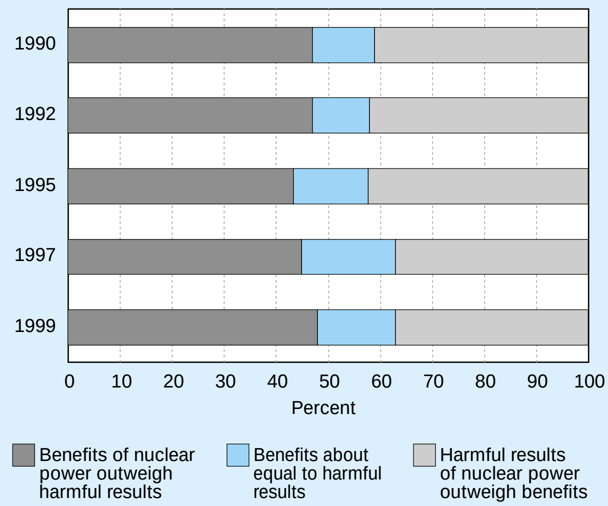
Individuals with more years of formal schooling, men, and those classified as attentive to science and technology policy are slightly more likely than others to believe the benefits of using nuclear power to generate electricity outweigh the harms. However, the correlation between education and attitudes toward use of nuclear power is relatively weak.

Figure 8-10.
Public assessment of scientific research: 1979–99 (selected years)



See appendix table 8-24. *Science & Engineering Indicators – 2000*

Figure 8-11.
Public assessment of nuclear power: 1990–99 (selected years)



See appendix table 8-25. *Science & Engineering Indicators – 2000*

Perceptions of Genetic Engineering

Data on public attitudes toward genetic engineering show no decline in the percentage of survey respondents who believe that the benefits outweigh the harmful results. In 1999, 44 percent of those interviewed agreed that the benefits either strongly or slightly outweigh the harms. (See figure 8-12 and appendix table 8-26.) This proportion is similar to that of the two previous surveys, despite the controversy generated by the widely reported news (in April 1997) about Dolly, the sheep cloned by a Scottish biologist and news (in January 1998) about a Chicago scientist planning to open a clinic for cloning people. (See sidebar, "The Most Closely Followed Science-Related News Stories: 1986–99.") Had the interviewers specifically mentioned cloning, the reaction from respondents may have been different, but the survey question did not include that word.[21]

The percentage of survey respondents who said that the harms outweighed the benefits was 38 percent in 1999. Among those classified as the attentive public for new medical discoveries (who may or may not be college graduates), the percentage agreeing that the harms are greater than the benefits rose from 30 percent in 1997 to 36 percent in 1999. (See figure 8-13.)

[21]In one poll, approximately 85 percent of the respondents said they oppose cloning human beings (Southern Focus 1998). In another poll, 69 percent of Floridians and 63 percent of Texans supported "research into the altering of human genes to treat disease" (Research! America 1999). Also, see sidebar, "Public Attitudes Toward Biotechnology."

Public Attitudes Toward Biotechnology

Before the recent controversy over genetically modified agricultural products erupted in Britain and other European countries, public opinion surveys on attitudes toward biotechnology were undertaken in Europe, Canada, and the United States.* Survey respondents were asked to assess the usefulness, risk, and moral acceptability of several applications of biotechnology and to say whether or not they would encourage each application (Miller *et al*. 1999).

Two sets of questions pertained to agricultural applications of biotechnology, including the use of genetic engineering in

- producing foods, for example, to make them higher in protein, allow them to keep longer, or change their taste, and
- making crops more resistant to insect pests.

Data collected with the three surveys show Europeans with less favorable attitudes than North Americans toward these two applications—in terms of all four criteria. The differences, however, were not large. For example,

- Fifty-five percent of the European survey participants agreed that genetically modified food is useful, compared with approximately two-thirds of the Canadian and U.S. respondents.
- Three-fifths of the Europeans agreed that genetically altered food is risky, compared with 55 percent and 53 percent of those in Canada and the United States, respectively.
- Half the Europeans said that genetically modified food is morally acceptable, compared with more than three-quarters of the Canadians and two-thirds of the Americans.
- Less than half the Europeans would encourage the production of genetically modified food, compared with nearly three-fifths of the North Americans.

The pattern of responses was similar for attitudes toward genetic modification of crops and other plants, although there seemed to be somewhat less support for this application of biotechnology. It is important to remember that the three surveys were conducted several years before the controversy surrounding genetically engineered food and crops made front-page headlines. Because the subject has received a considerable amount of press coverage, people may be better informed and have different opinions than those expressed when the surveys were conducted. (The author of the U.S. study noted that one of the problems in conducting a survey of public attitudes toward biotechnology is that many people do not have an attitude.)

Three sets of questions in the surveys pertained to medical applications of biotechnology:

- introducing human genes into bacteria to produce medicines or vaccines, e.g., to produce insulin for diabetics,
- using genetic testing to detect inherited diseases, and
- introducing human genes into animals to produce organs for human transplant, such as into pigs for human heart transplants.

The first two of these applications seem to have widespread public support in all three regions, although European support for medicine production lagged behind that of North Americans. However, European support for the genetic testing application was at least equal to that of the North Americans surveyed.

Attitudes toward the organ-transplant application were less favorable than those for the other two medical applications, with Europeans being somewhat more opposed than North Americans to this application, in terms of moral acceptability and whether or not the application should be encouraged.

*A 1996 Canadian survey, conducted by Professor Edna Einseidel, University of Calgary, used a national probability sample and included telephone interviews with 1,000 adults. The 1996 Eurobarometer on biotechnology was designed by a consortium of European scholars, organized and directed by Dr. John Durant of The Science Museum (London), and included personal interviews with 15,900 adults in the 15 member states of the European Union. A 1997 U.S. survey, directed by Professor Jon D. Miller, Northwestern University and the Chicago Academy of Sciences, used a national quota sample and included telephone interviews with 1,067 adults.

The relationship between a person's level of education and his or her assessment of the benefits and harms of genetic engineering shows some interesting trends. Although positive attitudes seemed to have increased (or stayed the same) between 1995 and 1999 for those without bachelor's degrees, the opposite seems to be true for those with degrees. The percentage of those in the latter group agreeing that the benefits outweigh the harms declined from 65 percent in 1995 to 55 percent in 1997, and then stayed the same in 1999. During the same period, among those with college degrees, the percentage saying the harms are greater than the benefits increased from 20 percent in 1995 to 24 percent in 1997 to 29 percent in 1999. (See figure 8-13.)

There is a significant gender gap in attitudes toward genetic engineering. Women are considerably more likely than men to believe the harms outweigh the benefits. In 1999, 42 percent of women agreed with this statement, compared with only 33 percent of men. The percentage-point difference has been 7 or more in four of the past five NSF surveys. (See figure 8-13 and appendix table 8-26.)

Perceptions of Space Exploration

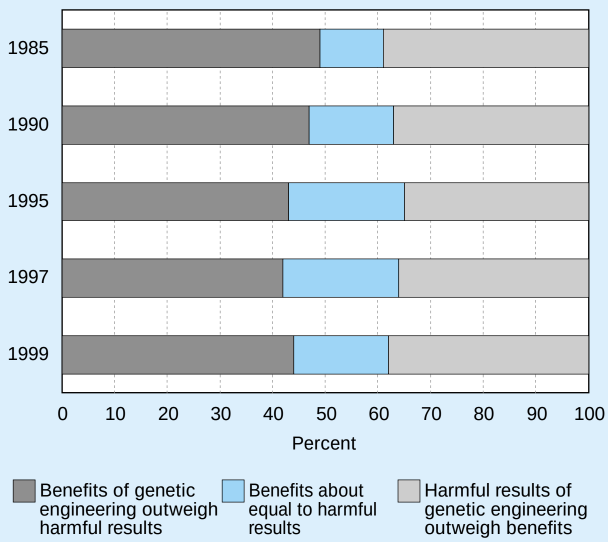
Before the Challenger accident, more than half the participants in NSF's public attitudes survey agreed that the benefits of space exploration exceeded the costs. Minds changed after the accident. The percentage agreeing that the benefits are greater than the costs fell from 54 percent in 1985 (before the explosion) to 47 percent in 1988 and to 43 percent in 1990. In the 1990s, this trend, an indicator of weakening support for the space program, leveled off. More recently, the percentage of survey respondents agreeing that the benefits are greater than the costs has been rising—from 43 percent in 1992 to 49 percent in 1999, approaching the 1985 level, before the Challenger accident. (See figure 8-14 and appendix table 8-27.)

In another poll, respondents were asked what they thought of the space program. More than half chose the response, "exciting and worthwhile"; 27 percent answered "only necessary to keep up with other nations"; and only 18 percent said it was "a waste of time and money." In response to another question, nearly half said that, in the future, the space program will make life on Earth better because of technological advances; 17 percent thought it would be worse because the money should have been spent on something else; and 32 percent thought the space program would not make life any better or worse (Roper 1996).

Like other issues, there is a sizeable gender gap in public assessment of space exploration. In fact, no other issue in the NSF survey has such a large disparity in opinion between the sexes. Men are more likely than women to champion the benefits over the costs. The gap was 14 percentage points in 1999.

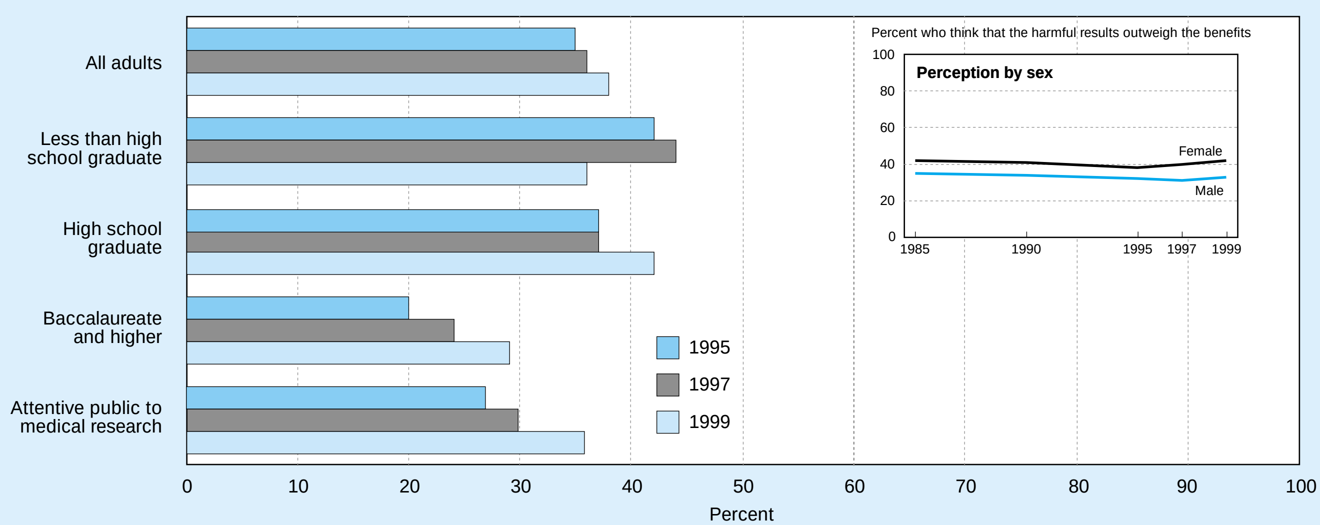
In every year but two (1990 and 1992), a majority of men interviewed for the survey agreed that the benefits outweigh the costs. The percentage stood at 57 percent in 1999, compared with 43 percent for women. In contrast, during the late 1980s and early 1990s, half or more of the women who participated in the survey thought that the costs exceeded the benefits. That is no longer true; the percentage dropped below 50 percent in 1997 and stayed there in 1999.

Figure 8-12.
Public assessment of genetic engineering: 1985–99 (selected years)



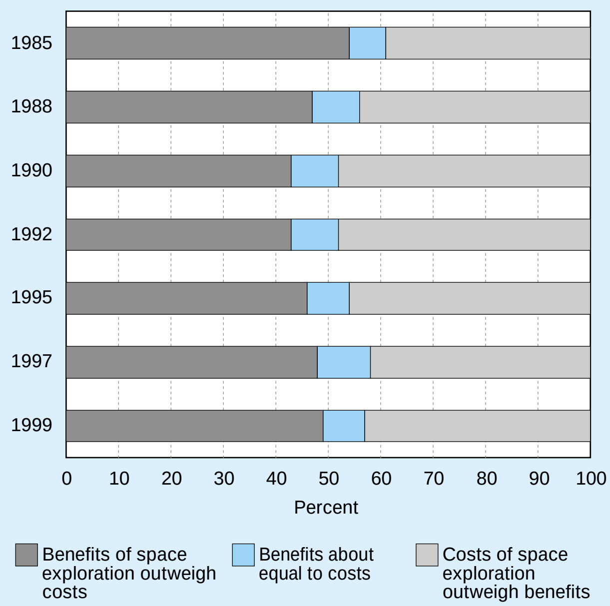
See appendix table 8-26. *Science & Engineering Indicators – 2000*

Figure 8-13.
Percentage of U.S. adults who view the harmful results of genetic engineering as outweighing the benefits: 1995, 1997, 1999



See appendix table 8-26. *Science & Engineering Indicators – 2000*

Figure 8-14.
Public assessment of space exploration: 1985–99 (selected years)



See appendix table 8-27. *Science & Engineering Indicators – 2000*

Those with more formal education are more likely than others to say that the benefits of space exploration exceed the cost. In 1999, only 40 percent of those with less than a high school education agreed that the benefits were greater than the costs, compared with 49 percent of those who graduated from high school and 60 percent of those with at least a bachelor's degree.

Those classified as attentive to science and technology—or to space exploration—are more likely than the public at large to believe that the benefits exceed the costs. At least 60 percent of each attentive group put the benefits ahead of the costs, compared with about half of the public at large.

Finally, about two-thirds of the public favor

- ♦ sending a U.S. manned mission to Mars (Roper 1996; and Southern Focus 1998) and
- ♦ building a space station (according to the NSF survey results).

Perceptions of the Use of Animals in Scientific Research

Few issues in science are as divisive as the use of animals in scientific research. There seems to be a 50–50 split in public opinion on this issue. (See appendix table 8-28.)

Public attitudes toward research using animals are shaped by:

- ♦ The purpose of the research. If animals are used in research on diseases such as cancer and AIDS, there is less opposition than if they are used in endeavors such as cosmetics testing.
- ♦ The type of animal. There is more tolerance for the use of mice in scientific experiments than for the use of dogs and chimpanzees.[22]
- ♦ The existence of alternatives, such as computer simulations. If they can accomplish the same purpose, then people will oppose the use of animals (Kimmel 1997).

Data from the NSF (and other) surveys show that:

- ♦ There was a slight increase in public opposition in the late 1980s.
- ♦ Compared with the citizens of other industrialized nations, Americans are more supportive of animal research (Kimmel 1997).

There are two major and long-standing fissures in public opinion on the use of animals in scientific research; that is, there are sex and age-related fault lines.

Women are far more likely than men to say they are opposed to the use of dogs and chimpanzees in scientific research. In 1999, nearly two out of every three women surveyed voiced opposition, whereas about one-third of the men held the same view. (See appendix table 8-28.) This gender gap in opinion cannot be attributed to differences between the sexes in science and mathematics education or differences in science literacy:

- ♦ At every education level, men are more likely than women to support the use of dogs and chimpanzees in scientific research. In 1995, 73 percent of men with graduate or professional degrees favored the use of these animals in scientific research, compared with 57 percent of the women in that educational category. For those with less than a high school education, the percentages were 59 percent and 45 percent, respectively.
- ♦ In addition, the number of science and mathematics courses taken is strongly related to men's attitudes toward animal research, but not at all related to women's attitudes.
- ♦ Among those classified as scientifically literate, 69 percent of the men, compared with only 48 percent of the women, expressed support for the use of dogs and chimpanzees in scientific research (Kimmel 1997).

Until the late 1990s, a fairly consistent relationship existed between age and attitudes toward animal research. Generally, the older the survey respondent, the more likely he or she was to express support for the use of animals in scientific research. It is widely assumed that the reason more positive attitudes are found among the elderly is that older persons

[22]Fewer people oppose the use of mice in scientific research; 30 percent of those surveyed opposed research on these creatures, compared with 47 percent who opposed research using dogs and chimpanzees. (See appendix tables 8-28 and 8-29.)

experience more health problems and therefore are more attuned to the need for medical research.[23]

In the past few years, the pattern has been less distinct. Now, all that can be said about the relationship between age and attitudes is that the 18- to 24-year-old age group is the *only* age group in which a majority opposes the use of dogs and chimpanzees in scientific research. (See figure 8-15.)

It is noteworthy that, for each age group, men are significantly more likely than women to support animal research. In no age group does a majority of women support the use of dogs and chimpanzees in scientific research.

Use of Computers and Computer Technology in the United States

There has been a marked increase in the number and variety of sources providing information about science and technology. (See chapter 9, "Significance of Information Technologies" and sidebar "Where Americans Get Information About Science and Technology.") Computers and computer technologies have become important in facilitating access to these new sources of information. According to the 1999 NSF survey, just over one-fifth of American adults have searched for science- or health-related information on the World Wide Web.

A number of indicators show the growing and widespread use of computers and computer-based technologies in the late 1990s. The increase in the number of home computers is particularly noteworthy.[24] In 1999, for the first time ever, a majority of American adults (54 percent) had at least one computer in their homes. The percentage has been rising steadily since 1983, when only 8 percent had them. (See figure 8-16 and appendix table 8-30.) In addition, among all adults,

- 46 percent had modems (for connection to the Internet) in their home computers, up from 21 percent in 1995;
- 45 percent had CD-ROM readers, up from 14 percent in 1995;
- 32 percent subscribed to an on-line service and had home e-mail addresses, up from 18 percent in 1997; and
- 17 percent had more than one computer in their homes, up from 12 percent in 1997. (See figure 8-17 and appendix table 8-31.)

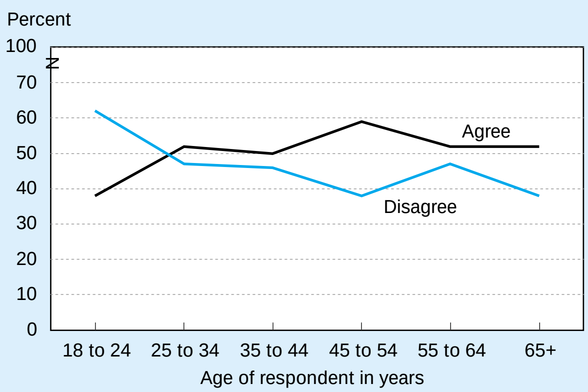
The average amount of time spent per year using a home computer rose from 103 hours in 1995 to 153 hours in 1999.

[23]It should be noted that the survey data are cross-sectional, rather than longitudinal. Although it can be assumed that, as adults age and experience more health problems, they become more receptive to the use of animals in scientific research, it is also possible that the older adults who participated in the survey have always been—throughout their lives—more supportive of animal research than the younger participants in the survey. Likewise, it is also possible that the current group of younger adults who participated in the survey will retain their higher level of opposition as they age.

One of the reasons for the high level of opposition to animal research among young adults is that animal rights groups, which distribute brochures to schools and use young celebrities to promote their cause, have been successful in influencing young people, especially girls. One study found that factors beyond educational achievement and science literacy, for example, a strong emotional component, account for the strong opposition among young women. Interestingly, this study revealed that the level of science achievement among girls who opposed animal research was higher than that for girls who favored animal research (Kimmel Pifer 1994).

[24]In a poll conducted in 1996, 43 percent of the respondents said they were very interested, and another 33 percent said they were somewhat interested, in learning more about computers. Among this same group of respondents, 45 percent thought that home computers would make it easier to do things like shopping, paying bills, making travel arrangements, and looking things up electronically instead of going to a library or buying books or newspapers; 16 percent thought using a computer would make doing these activities more complicated (Roper 1996).

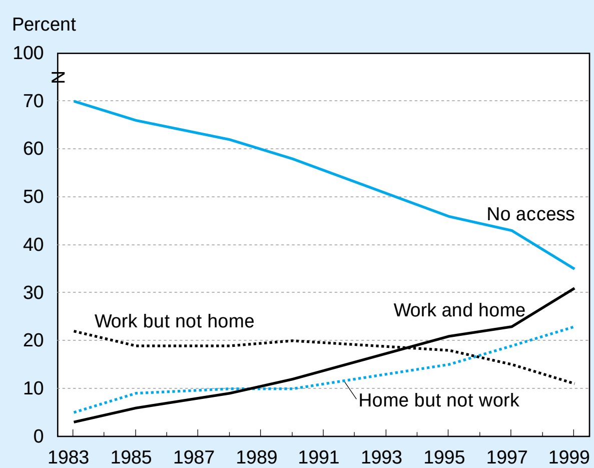
Figure 8-15.
U.S. public support for the use of dogs and chimpanzees in scientific research: 1999



NOTE: Responses are to the following question: "Scientists should be allowed to do research that causes pain and injury to animals such as dogs and chimpanzees if it produces new information about human health problems. Do you strongly agree, agree, disagree, or strongly disagree?"

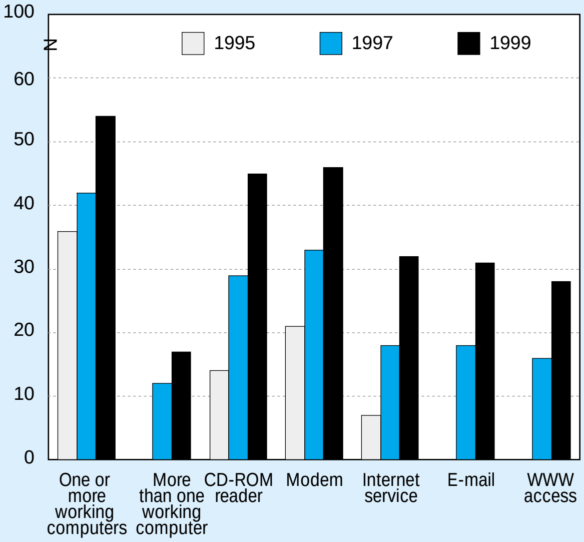
See appendix table 8-28. *Science & Engineering Indicators – 2000*

Figure 8-16.
Public access to computers: 1983–99



See appendix table 8-30. *Science & Engineering Indicators – 2000*

Figure 8-17.
Home access to computers: 1995, 1997, 1999



See appendix table 8-31. *Science & Engineering Indicators – 2000*

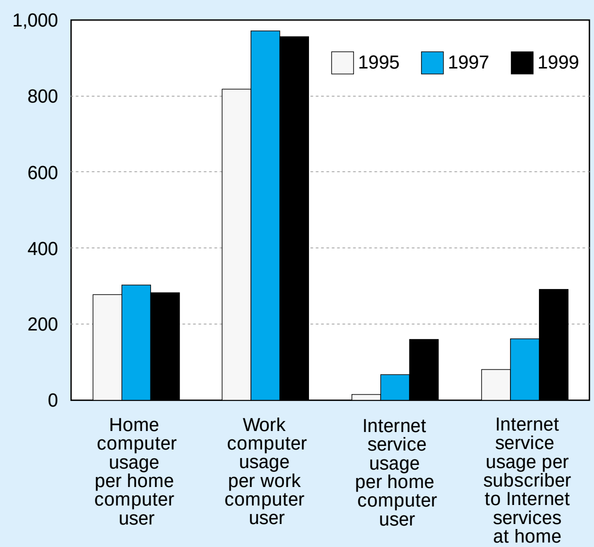
Text table 8-5.
Public's use of home computers, work computers, and the Internet

Variable	1995	1997	1999
Percentage of public with			
Access to a home computer	37	43	54
Access to a computer at work	39	38	42
Subscription to online service at home	7	18	32
Average time spent per year			
On home computer for home computer users in hours	278	302	283
On work computer for work computer users in hours	818	971	957
Average time spent online at home per year in hours			
For the general public	6	29	86
For home computer users	15	67	159
For Internet users	80	161	296

See appendix table 8-32 and previous editions of *Indicators.*

Science & Engineering Indicators – 2000

Figure 8-18.
Computer usage: average hours per year: 1995, 1997, 1999



See text table 8-5.

Science & Engineering Indicators – 2000

(See appendix table 8-32.) This increase, however, is almost entirely attributable to growth in the number of home computers. The average amount of time each person spends using his or her home computer remained relatively stable during the late 1990s, around 300 hours per year. (See figure 8-18.) However, a shift occurred in how that time was spent. More time is being spent on the Internet and less on other activities, for example, word processing. Among all home computer users, the amount of time spent on the Internet increased more than tenfold between 1995 and 1999 (from 15 hours per year to approximately 160). In addition, for those with Internet access, the amount of time spent on Internet activities, including using e-mail and visiting Web sites, increased from an average of 80 hours in 1995 to 269 hours in 1999. (See figure 8-18.)

The number of people with access to a computer at work has also been climbing, but the increase has been less dramatic. In 1983, one-fourth of the NSF survey respondents reported using a computer at work, and about one-third said they did in 1990. The proportion was up to 42 percent in 1999. (See figure 8-16 and appendix table 8-30.) In addition,

- Twenty percent of those surveyed had e-mail addresses at work, up from 16 percent two years earlier (see appendix table 8-31).
- The average amount of time spent using a computer at work increased 17 percent between 1995 and 1999, to about 950 hours per year. (See figure 8-18 and text table 8-5.)

The number of people *without* access to a computer either at home or at work fell between 1983 and 1999—from 70 percent down to 35 percent. In 1999, for the first time, there was no gender gap in lack of access. (See appendix table 8-30.)

Differences in computer access, the so-called "digital divide," are quite visible when level of formal education is taken into account. More than 70 percent of those who lack a high school diploma had no access to a computer either at home or at work in 1999. In contrast, only 30 percent of those who graduated from high school, and only 8 percent of those with at least a bachelor's degree, lacked access. Although access has been rising in all three groups, the pace is significantly slower for those with less formal education, and what increase there has been is entirely attributable to home computer acquisition, not access in the workplace. As an illustration, in 1983, less than 1 percent of those without high school diplomas had computers in their homes. By 1990, the proportion had grown to 7 percent, and by 1999, it had increased to 22 percent. During the same 16-year period, access to computers at work did not rise above 10 percent. Clearly, there is a difference in computer acquisition between those who did not finish high school and those with more formal education, but there is an even greater disparity in the use of computers in the workplace. (See figure 8-19 and appendix table 8-30.) For more information on this subject, see the section on "Information Technologies and the Citizen" in chapter 9.

The Relationship Between Science and the Media: Communicating with the Public

Most of what most Americans know about science and technology comes from watching television or reading a newspaper. (See sidebar, "Where Americans Get Information about Science and Technology.") Thus, the media serve as a crucial conduit between the science and engineering community and the public at large.

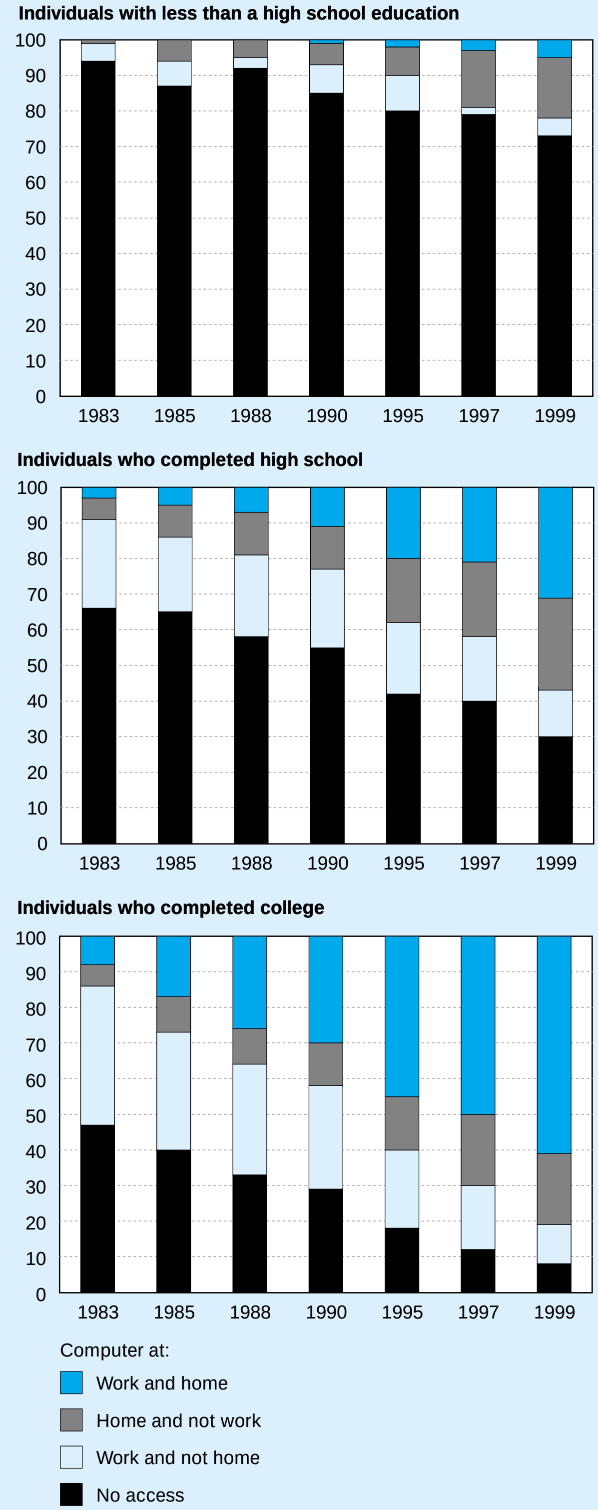
Findings from a recent study conducted by the First Amendment Center[25] revealed a general consensus that the science community and the press are missing opportunities to communicate with each other and with the public:

> [T]he frequent inability of science and the media to communicate effectively with each other seriously undermines science literacy among the general public. This, in turn, creates an electorate ill-prepared to make informed judgments about major issues related to science, health, and technology, such as global warming and human cloning, as well as multi-billion-dollar federal investments in research and development (Hartz and Chappell 1997).

The public needs to be informed about the importance of science and technology, because tax dollars fund a sizable portion of the nation's R&D enterprise—an estimated $66.6 billion in 1998. (See chapter 2, "U.S. and International Research and Development: Funds and Alliances.") The public should know what it is buying with that investment. In addition, the science and engineering community, which relies fairly heavily on public financing for both its employment and its education, is also dependent on the news media to inform the public about the work that it does.

The relationship between the media and the science and engineering community has been the focus of considerable

Figure 8-19.
Access to computers, by level of education: 1983–99 (selected years)



See appendix table 8-30. *Science & Engineering Indicators – 2000*

[25]All information in this section (unless otherwise specified) comes from the report *Worlds Apart: How the Distance between Science and Journalism Threatens America's Future* (Hartz and Chappell 1997). This report contains findings from a study conducted by Jim Hartz (a veteran television and print journalist who has covered science extensively) and Rick Chappell (associate director for science at NASA's Marshall Space Flight Center in Huntsville, Alabama). The Freedom Forum First Amendment Center is affiliated with Vanderbilt University and its Institute for Public Policy Studies.

Where Americans Get Information about Science and Technology

Television is the leading source of information about new developments in science and technology, followed by books and newspapers.* According to the 1999 NSF survey, each adult watches an average of about 1,000 hours of television per year; 42 percent of those hours are devoted to television news and 4 percent to shows about science.** (See appendix table 8-33.)

Men watch more science shows than women; the 1999 survey data indicate that men watch an average of 46 hours per year, compared with 38 for women. Those with more formal education and those who have taken more science and mathematics courses tend to watch more television shows devoted to science than those with less education, but the differences are not substantial. (See appendix table 8-33.)

Cable television subscribers watch significantly more science shows than those without cable. The 1999 data indicate that cable subscribers watch an average of 50 hours per year, compared with 20 hours for individuals without the service. (See appendix table 8-33.)

The most recent data show Americans reading an average of 178 newspapers, 11 news magazines, and 3 science magazines per year. (See appendix table 8-33.) However, the percentage of all adults who read a newspaper every day has been declining—from 62 percent in 1983 to 41 percent in 1999.*** (See appendix tables 8-34 and 8-35.) The decline is apparent at all education levels. (See figure 8-20.)

*In one survey, 40 percent of the respondents said they pay a lot of attention to programs about science and technology; 46 percent said they pay a lot of attention to news reports about science on evening news shows or programs such as *20/20* or *Nightline* (Roper 1996).

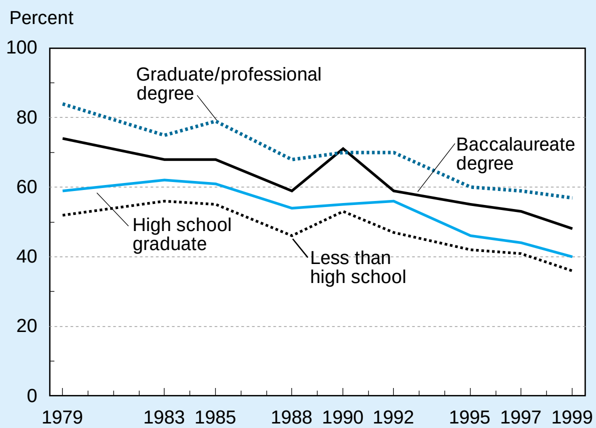
**Since respondents were asked to name the science shows they watch regularly or periodically, this is a credible estimate of viewership.

***A focus group study revealed that *Washington Post* readers spend an average of only 22 minutes per day reading the paper (Suplee 1999).

The 1999 data indicate that Americans visit a public library an average of 9 times per year, and they borrow an average of 11 books and 1 videotape during that time frame. Sixty-two percent of those surveyed bought at least one book during the preceding 12-month period, and 33 percent said that they bought at least one book about science, mathematics, or technology (including computer use). (See appendix tables 8-33 and 8-34.)

About three out of every five Americans visit a science museum, natural history museum, zoo, or aquarium at least once per year. Museum attendance is positively related to formal education and attentiveness to science and technology. (See appendix tables 8-34 and 8-36.)

Figure 8-20.
Percentage of the U.S. public reading a newspaper every day: 1979–99



See appendix table 8-35. *Science & Engineering Indicators – 2000*

scrutiny. Interest has grown in the past decade, probably because with the end of the Cold War, Federal support for R&D is not quite as solid as it once was. That is, R&D is facing stiffer competition among competing priorities within the Federal budget. (See chapter 2, "U.S. and International Research and Development: Funds and Alliances.")

To identify the problems and develop recommendations for improving the relationship between science and the media, the First Amendment Center conducted a survey wherein both journalists and scientists were asked the same series of questions.[26] (Because only about one-third of each group submitted completed questionnaires, these findings should be treated with caution.) In addition, the survey findings were discussed at a forum on the topic.[27] A report was then prepared that contains a comprehensive description of the issues and recommendations for improving the relationship between science and the media. (See footnote 25).

What Are the Problems?

Distrust of the Media

The survey revealed a lack of confidence in the press. Only 11 percent of the scientists reported having a great deal of confidence in the press, and 22 percent said they have hardly any. (Comparable percentages for the journalists were 35 per-

[26]Questionnaires were sent to 2,328 journalists, including (1) 1,036 individuals identified in the *Editor & Publisher* yearbook as editors, managing editors, or science correspondents or editors working at newspapers with circulations greater than 50,000 and (2) all 1,292 active members of the Radio-Television News Directors Association. For the scientists in the survey, 2,002 names were drawn randomly from the list of medical researchers of the American Medical Association and the membership lists of the American Geophysical Union, the American Physical Society, the Federation of American Societies of Experimental Biology, and the American Astronomical Society. About one-third of both the journalists and the scientists submitted completed questionnaires.

[27]The panel discussion was held on October 3, 1997, as part of a two-day event to commemorate the 40th anniversary of the launch of the Sputnik satellite.

Y2K Awareness and Concerns

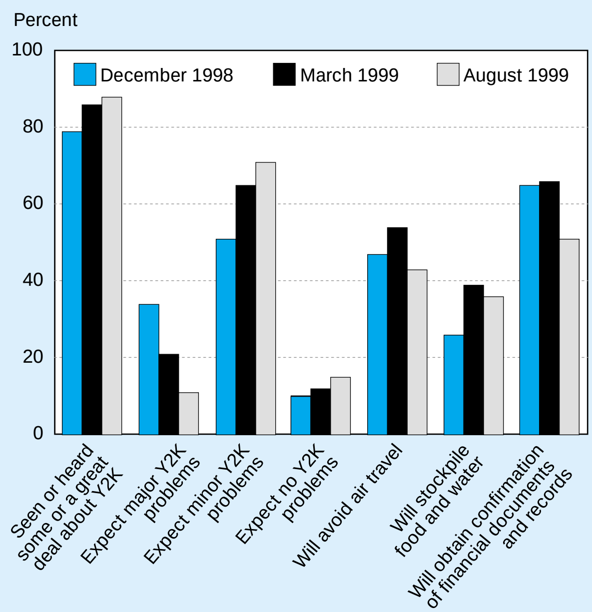
Media publicity about the Y2K problem seems to have worked. (Of course, the Y2K issue turned out to be a non-issue.) Data from several polls—including one conducted in December 1998, another in March 1999, and a third in August 1999—indicated

- A growing awareness of the Y2K issue, which refers to potential problems caused by computers not programmed to recognize dates after December 31, 1999. More than 85 percent of those polled in March and August 1999 said they had seen or heard "some or a great deal" about the so-called Millennium Bug, up from 79 percent in late 1998. (See figure 8-21.)
- A lessening of concern. The percentage of respondents anticipating major problems on January 1, 2000, fell from 34 percent in December 1998 to 21 percent in March 1999 to 11 percent in August 1999. However, concern remained over air travel, food shortages, and financial account accuracy. In August 1999,
  - 35 percent said it is likely that air traffic control systems will fail, down from 43 percent recorded three months earlier;
  - 35 percent said it is likely that food and retail distribution systems will fail (possibly causing grocery and other store shortages), down slightly from the previous surveys; and
  - 48 percent said that it is likely that banking and accounting systems will fail, down from 55 percent in March and 63 percent in December.
- A decrease in the number of people planning to take precautions. In August 1999,
  - 43 percent said they would avoid traveling on airplanes on or around January 1, 2000, down from 54 percent in March;
  - 36 percent said they would stockpile food and water, compared with 39 percent in March; and
  - 51 percent said they would obtain special confirmation or documentation of their bank account balances, retirement funds, or other financial records, down from 66 percent in the previous survey. (See figure 8-21.)

Most of those polled expressed:

- A high level of confidence (more than 80 percent in August 1999) in local, state, and Federal Government agencies' and large companies' ability to upgrade their computer systems before the end of 1999.
- Less confidence in other developed and industrialized countries' governments (49 percent)—and in small companies (65 percent, compared with 91 percent for large companies)—being able to meet the deadline; and
- Little confidence (less than 20 percent) in the governments of Third World or other less developed countries' ability to make the necessary software revisions.

Figure 8-21.
Public perception of and reaction to the "Year 2000 bug": 1998–99



SOURCE: *USA Today*/NSF/Gallup Poll,1999. "Americans and the Y2K Millennium Computer Bug."

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cent and 4 percent, respectively.) Confidence in television media was even lower: nearly half (48 percent) of the scientists said they have hardly any confidence in it (compared with 27 percent for the journalists).[28] It is noteworthy that of all groups surveyed by the First Amendment Center (including the clergy, corporate leaders, the military, and even politicians), none was as distrustful of the news media as the scientists.

In addition, the media were faulted for failing to understand the process of scientific investigation, oversimplifying complex issues, and focusing on trendy discoveries:

- The vast majority of the scientists either strongly (52 percent) or somewhat (39 percent) agreed with the statement, "Few members of the news media understand the nature of science and technology, such as the tentativeness of most scientific discovery and the complexities of results." (Comparable percentages for the journalists were 23 percent and 54 percent, respectively.)

[28]Interestingly, the journalists' responses to several questions indicated a higher level of confidence in the scientific community than in their own professional community. Also, the public in general has relatively little confidence in the press and TV. (See figure 8-9 and appendix table 8-23.)

- More than half (56 percent) of the scientists either strongly or somewhat agreed with the statement, “Members of the news media rarely get the technical details about science and technology correct.” (Only one-fifth of the journalists agreed or somewhat agreed with the statement.)
- About three-quarters of the scientists either strongly (30 percent) or somewhat (46 percent) agreed with the statement, “Most members of the news media are more interested in sensationalism than in scientific truth.” (Comparable percentages for the journalists were 5 percent and 17 percent, respectively.) (See figures 8-22 and 8-23.)

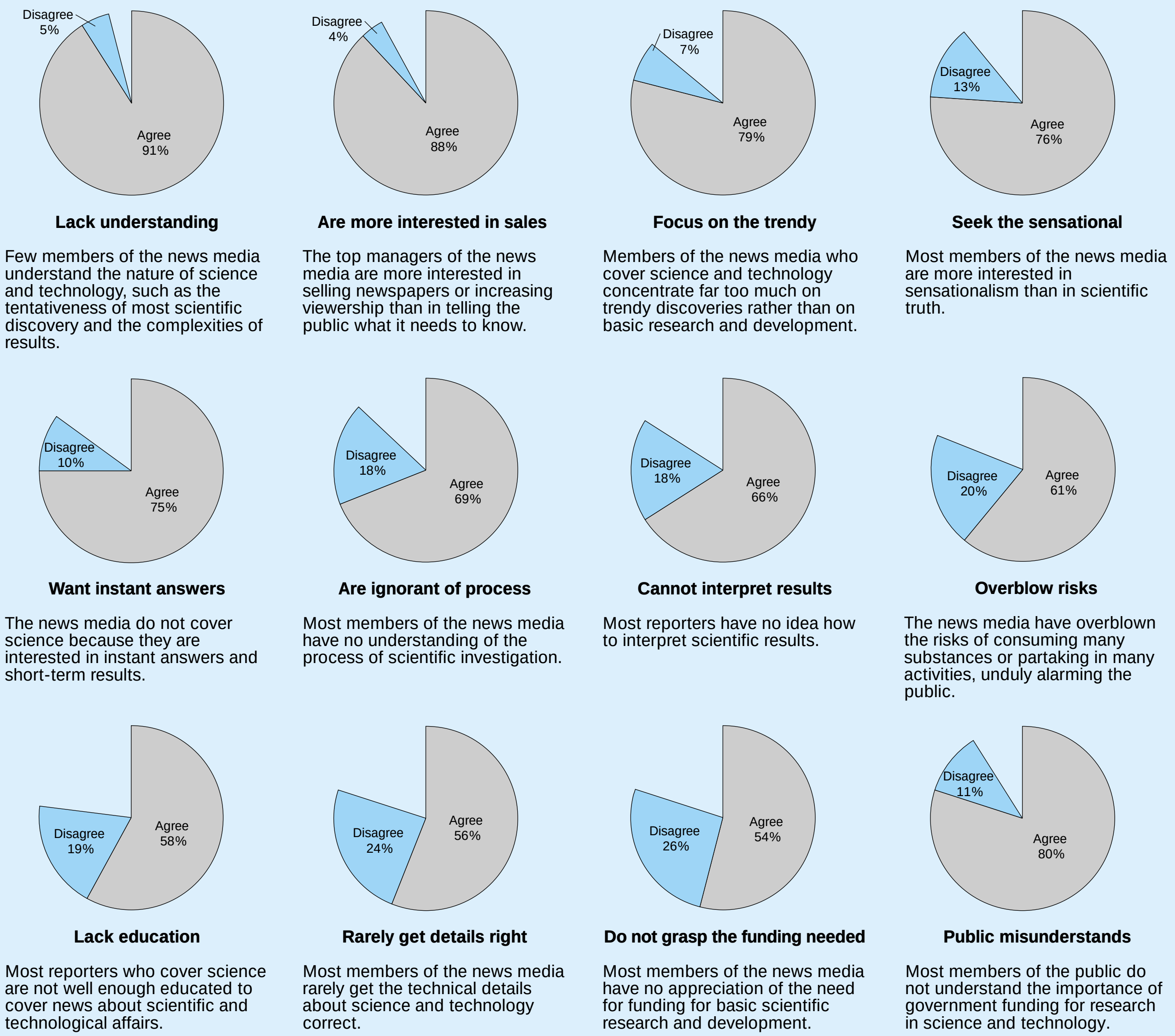
Perceived Lack of Interest in Science

News decisionmakers may decide not to cover science stories. Few editors have any formal training in science.[29] These “gatekeepers” may

- believe their readers or listeners are uninterested in science stories and will not be able to understand them;
- allow the bad experiences they may have had with high

[29] Although half the journalists who participated in the First Amendment Center survey had covered science, only 6 percent reported having science degrees.

Figure 8-22.
Scientists' agreement with various negative statements about the news media



NOTE: The percentage not accounted for in each of these charts represents those scientists who answered "neither agree nor disagree."

SOURCE: J. Hartz and R. Chappell, *Worlds Apart: How The Distance Between Science and Journalism Threatens America's Future* (Nashville, TN: Freedom Forum First Amendment Center, 1997).

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school or college science courses to influence their decisionmaking;

- ♦ think that, because their publications or programs are devoting sufficient space or time to stories about medicine and health, they are doing an adequate job of covering science; and
- ♦ claim that science sections fail to attract advertisers.[30]

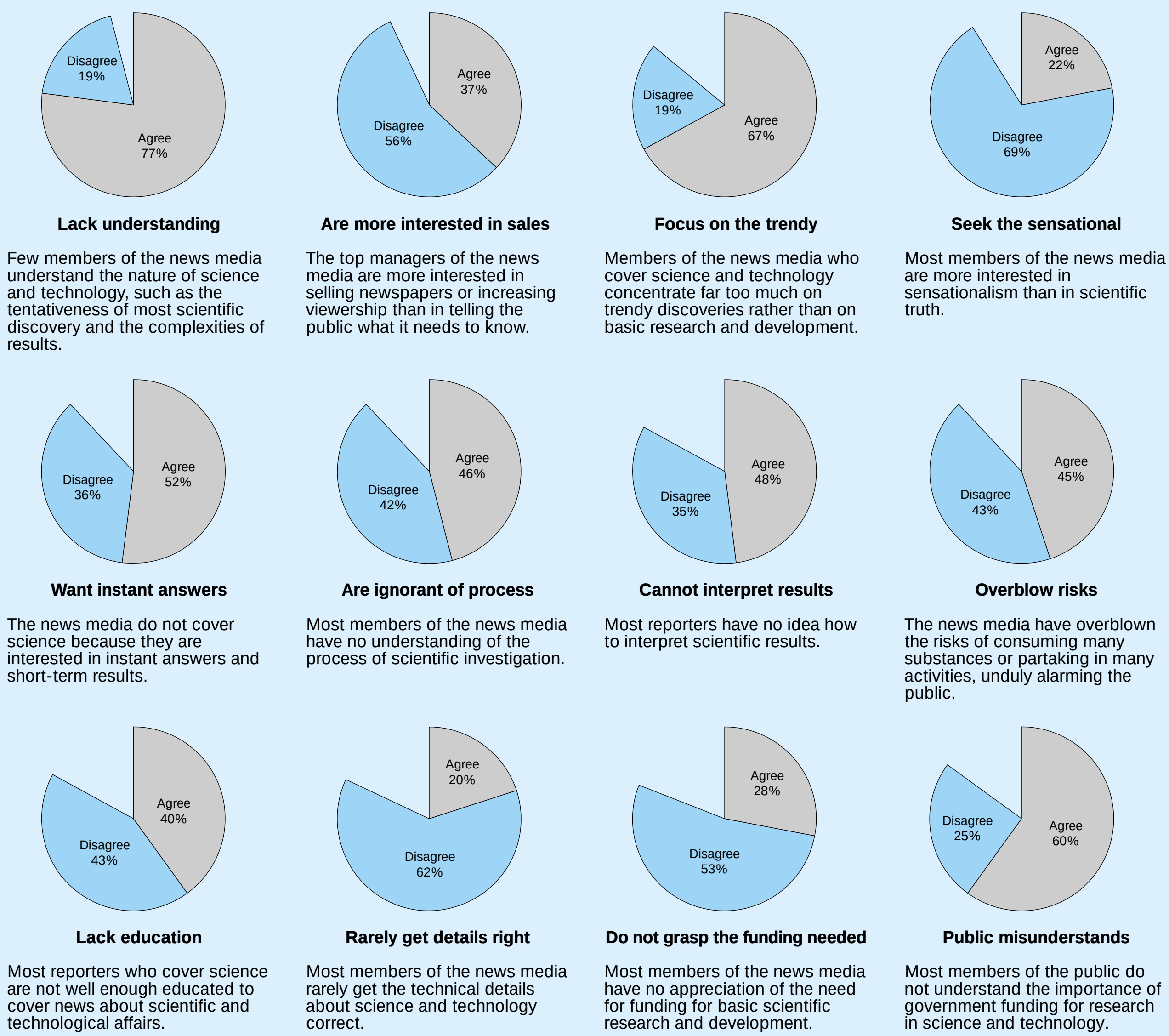
[30]It is widely assumed that people who read science news are not large purchasers of the type of consumer products most heavily advertised in newspapers. In addition, science sections of major newspapers have traditionally been supported by computer ads and the number of computer manufacturers has been shrinking (Suplee 1999).

Communication Barriers

Scientists tend to use technical jargon instead of plain English when discussing their work. Also, they have yet to master the "sound bite." They have a penchant for citing numerous qualifications when describing their findings, rather than summing up their research in one or two sentences. This communication style makes it difficult for science reporters to do their job.

Scientists also have a reputation for not being very good at identifying what is newsworthy and relevant to readers or listeners. According to one reporter, "scientists are sometimes

Figure 8-23.
Journalists' agreement with various negative statements about the news media



NOTE: The percentage not accounted for in each of these charts represents those journalists who answered "neither agree nor disagree."

SOURCE: J. Hartz and R. Chappell, *Worlds Apart: How The Distance Between Science and Journalism Threatens America's Future* (Nashville, TN: Freedom Forum First Amendment Center, 1997).

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bad judges of their best stories" (P. Conti, as quoted in Hartz and Chappell 1997, 92). Therefore, the message to scientists should be:

> ...Two things...are vital and...found in nearly all good stories about science: relevance and context. Since so much of science is incremental, the reporter and the public need special help in placing research in the context of the big picture.…(Hartz and Chappell 1997, 93).

Most scientists are unaccustomed to discussing their work with anyone other than their peers or students. Also, in the past, scientists were often able to take funding for granted; that is, they rarely needed to justify and explain their work to the public. This may account for their lack of experience in communicating with lay audiences through speaking engagements, on television, on the radio, and in writing for the popular press.[31]

Scientists are often reluctant to talk to the press, and rarely do so.[32] Undoubtedly, some of this lack of media contact is related to the feelings of distrust discussed previously. Also, scientists may seem overly concerned with how they are perceived by their peers. One of the most frequently cited reasons for scientists' reluctance to talk to the press is the so-called Carl Sagan effect, that is, renowned scientist Carl Sagan was criticized by his fellow scientists who assumed that because Sagan was spending so much time communicating with the public, he must not have been devoting enough time to his research.[33] Another reason that may cause scientists to evade the press is a fear of being misquoted or having their work mischaracterized; in such cases, their colleagues would have no way of knowing whether the scientist or the reporter was at fault.

An Ill-Informed and Poorly Educated Public

Although scientists and journalists do not see eye-to-eye on several issues, both agree that there is a need for a better informed and educated public.[34] In the First Amendment Center survey, more than two-thirds of the journalists and more than three-quarters of the scientists strongly or somewhat agreed with the statement: "The American public is gullible about much science news, easily believing in miracle cures or solutions to difficult problems." Moreover, 60 percent of the journalists and 80 percent of the scientists strongly or somewhat agreed with the statement: "Most members of the public do not understand the importance of government funding for research" and therefore do not understand what they are getting from their investment in R&D. (See figures 8-22 and 8-23.)

The state of science education has been a major concern because scientific and technological advancements are having an increasingly pervasive impact on modern life. (See chapter 5, "Elementary and Secondary Education.") Both sets of respondents cited weaknesses in science education in their survey questionnaires.[35] Not only does the education system not do as good a job as it should in imparting basic scientific knowledge, it also lets too many students slide through without developing good critical thinking skills, skills crucial in a society in which informed decisionmaking is becoming increasingly important and more complex. (See the section "Belief in the Paranormal or Pseudoscience.")

What Should Be Done To Improve the Relationship?

Both scientists and journalists participating in the First Amendment Center project demonstrated a willingness to improve their working relationship. More than three-quarters of the scientists said they would be willing to take a course designed to help them communicate better with journalists and the public, and more than 90 percent said they would be willing to participate in an ongoing dialogue with members of the news media.

After reviewing the survey findings and listening to ideas exchanged at the forum, participants developed the following recommendations, which were included in the First Amendment Center report:

- Scientists and reporters should engage in an ongoing dialogue with each other to learn how both can do a better job of communicating with the public.
- Professional societies and other organizations representing scientific disciplines should maintain Web sites that contain the telephone numbers and e-mail addresses of scientists available to talk to the press. These Web sites should also contain information useful to the press and the general public and should have links to a master Web site main-

[31]The President's Science Advisor, Dr. Neal Lane, often speaks and writes about "the importance of scientists getting out of their labs, off their campuses, away from their computers, and into a dialogue with the American public." According to Dr. Lane, "A partial solution to this disconnect [between the science community and the public] is to educate scientists on how to be better communicators not only about their particular work but about the role and value of science and technology to society" (Neal Lane, speech before the Arlington Rotary Club, July 25, 1996).

[32]Nearly one-fourth of the scientists who participated in the First Amendment Center survey said they had never been interviewed or written about in a science news story; 45 percent answered "every few years." In a recent article, one host of a talk show in the United Kingdom described what a difficult time he had getting scientists to appear on his program: "The excuses varied but I discovered a deep-seated suspicion among British scientists about how they would be received by a nonscientific audience" (Bragg 1998).

[33]Sagan "was actually denied membership in the National Academy of Sciences, in part because many of the members felt it was unseemly for him to be so popular, so well-spoken, to get so many lucrative book contracts" (Hartz and Chappell 1997).

[34]The state of science education was the most frequently mentioned topic among the comments provided by the scientists on their questionnaires. A number of scientists have even observed, with dismay, what may be described as a cultural bias against science literacy. One scientist, who is also a Congressman, noted that it has "become fashionable to be ignorant about science" (The American Institute of Physics 1999).

[35]According to the NSF survey, a majority of Americans believes that the quality of science and mathematics education in U.S. schools is inadequate. But that proportion has been falling. Three-quarters of those surveyed held that view in 1992 and two-thirds did in 1999. (See appendix table 8-37.) In another poll, 57 percent of the respondents strongly agreed, and 28 percent somewhat agreed, with the statement that "unless we put more emphasis on science in the schools, we won't have the trained people we will need for life in the twenty-first century" (Roper 1996).

tained by either the American Association for the Advancement of Science or the National Academy of Sciences.

- Each article published in a scientific journal should include a brief summary—written in plain English—that contains the author's major findings and a brief explanation of the research's importance and relevance.
- Future scientists should be required to take undergraduate courses in communications, and future journalists should be required to take courses in science (to gain a better understanding of the scientific process).
- Journalists should approach what may appear to be groundbreaking research with caution, paying heed to the peer-review process, before reporting on the research.
- The scientific community should train spokespersons for each discipline, and scientists should welcome opportunities to talk about their work with the press and the general public.[36]

Belief in the Paranormal or Pseudoscience[37]

Does it matter if people believe in astrology, extrasensory perception (ESP), or that aliens have landed on Earth? Are people who check their horoscopes, call psychic hotlines, or follow stories about alien abductions just engaging in harmless forms of entertainment? Or, are they displaying signs of scientific illiteracy?

Concerns have been raised, especially in the science community, about widespread belief in paranormal phenomena. Scientists (and others) have observed that people who believe in the existence of paranormal phenomena may have trouble distinguishing fantasy from reality. Their beliefs may indicate an absence of critical thinking skills necessary not only for informed decisionmaking in the voting booth and in other civic venues (for example, jury duty[38]), but also for making wise choices needed for day-to-day living.[39]

[36]One journalist advises scientists to "track the ways that the popular media report basic research and interpret its value." According to the writer, "scientists can get clues [about how to improve] their communication skills with the media by noting what editors choose to cover, what they dismiss as uninteresting, and, more subtly, how they sometimes fail to make connections or provide perspective" (Lewis 1996).

[37]Pseudoscience has been defined as "claims presented so that they appear [to be] scientific even though they lack supporting evidence and plausibility." In contrast, science is "a set of methods designed to describe and interpret observed and inferred phenomena, past or present, and aimed at building a testable body of knowledge open to rejection or confirmation" (Shermer 1997). Paranormal topics include yogic flying, therapeutic touch, astrology, fire walking, voodoo magical thinking, Uri Geller, placebo, alternative medicine, channeling, Carlos hoax, psychic hotlines and detectives, near death experiences, UFOs, the Bermuda Triangle, homeopathy, faith healing, and reincarnation (Committee for the Scientific Investigation of Claims of the Paranormal).

[38]Because of several well-publicized court cases, considerable attention has been focused on the role of science in the courtroom and the ability of judges and juries to make sound decisions in cases involving highly complex, science- or technology-based evidence. (See Angell 1996 and Frankel 1998.)

[39]A fairly common example that reflects a dearth of critical thinking skills is the number of people who become victims of get-rich-quick (for example, pyramid) schemes.

Specific harms caused by paranormal beliefs have been summarized as:

- a decline in scientific literacy and critical thinking;
- the inability of citizens to make well-informed decisions;
- monetary losses (psychic hotlines, for example, offer little value for the money spent);
- a diversion of resources that might have been spent on more productive and worthwhile activities (for example, solving society's serious problems);
- the encouragement of a something-for-nothing mentality and that there are easy answers to serious problems, for example, that positive thinking can replace hard work; and
- false hopes and unrealistic expectations (Beyerstein 1998).

For a better understanding of the harms associated with pseudoscience, it is useful to draw a distinction between *science* literacy and *scientific* literacy. The former refers to the possession of technical knowledge. (See "Understanding Terms and Concepts" in the section "Public Understanding of Science and Technology.") Scientific literacy, on the other hand, involves not simply knowing the facts, but also requires the ability to think logically, draw conclusions, and make decisions based on careful scrutiny and analysis of those facts (Maienschein 1999; Peccei and Eiserling 1996).

The amount of information now available can be overwhelming and seems to be increasing exponentially. This has led to "information pollution," which includes the presentation of fiction as fact. Thus, being able to distinguish fact from fiction has become just as important as knowing what is true and what is not. The lack of this ability is what worries scientists (and others), leading them to conclude that pseudoscientific beliefs can have a detrimental effect on the well-being of society.[40] (See "An Ill-Informed and Poorly Educated Public" in the section "The Relationship between Science and the Media: Communicating with the Public.")

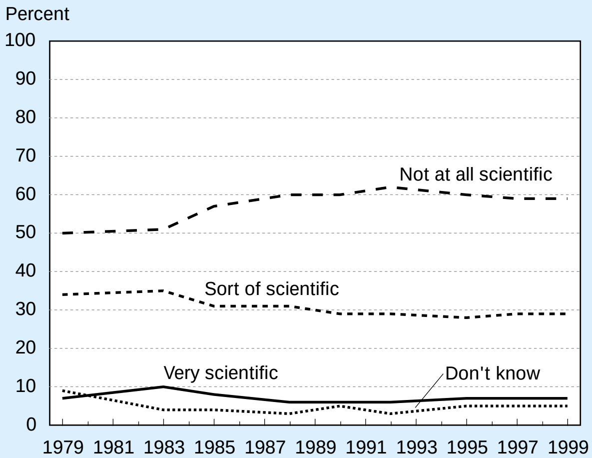
Belief in the Paranormal: How Common Is It?

Belief in the paranormal seems to be widespread. Various polls have shown that

- As many as one-third of Americans believe in astrology, that is, that the position of the stars and planets can affect people's lives (Harris 1998, Gallup 1996, and Southern Focus 1998). In 1999, 7 percent of those queried in the NSF survey said that astrology is "very scientific" and 29 percent answered "sort of scientific." (See figure 8-24.) Twelve percent said they read their horoscope every day

[40]According to J. Randi, "acceptance of nonsense as mere harmless aberrations can be dangerous to us. We live in an international society that is enlarging the boundaries of knowledge at an unprecedented rate, and we cannot keep up with much more than a small portion of what is made available to us. To mix our data input with childish notions of magic and fantasy is to cripple our perception of the world around us. We must reach for the truth, not for the ghosts of dead absurdities" (Randi 1992).

Figure 8-24.
Public perception of whether astrology is scientific: 1979–99



See appendix table 8-38. *Science & Engineering Indicators – 2000*

or "quite often"; 32 percent answered "just occasionally."[41] (See appendix tables 8-38 and 8-39.)

- Nearly half or more believe in extrasensory perception or ESP (Gallup 1996; Southern Focus 1998). According to one poll, the number of people who have consulted a fortune-teller or a psychic may be increasing: in 1996, 17 percent of the respondents reported contact with a fortune-teller or psychic, up from 14 percent in 1990 (Gallup 1996).[42]
- Between one-third and one-half of Americans believe in unidentified flying objects (UFOs). A somewhat smaller percentage believes that aliens have landed on Earth (Gallup 1996; Southern Focus 1998).

Other polls have shown one-fifth to one-half of the respondents believing in haunted houses and ghosts (Harris 1998; Gallup 1996; Sparks, Nelson, and Campbell 1997), faith healing (Roper 1994, *USA Today* 1998), communication with the dead (Gallup 1996), and lucky numbers. (See appendix table 8-40.) Some surveys repeated periodically even show increasing belief in these examples of pseudoscience (*USA Today* 1998).

Belief in most—but not all—paranormal phenomena is higher among women than men. More women than men believe in ESP (especially telepathy and precognition), astrology, hauntings, and psychic healing. On the other hand, men have stronger beliefs in UFOs and bizarre life forms, for example, the Loch Ness monster (Irwin 1993). In the NSF survey, 39 percent of the women, compared with 32 percent of the men, said astrology is "very" or "sort of" scientific; 56 percent of the women, compared with 63 percent of the men, answered "not at all scientific."[43] (See appendix table 8-38.)

Not surprisingly, belief in astrology is negatively associated with level of education.[44] Among those without high school diplomas, only 41 percent said that astrology is "not at all scientific." The comparable percentages for high school and college graduates are 60 percent and 76 percent, respectively. (See appendix table 8-38.)

Do the Media Have a Role in Fostering Belief in the Paranormal?

Scientists and others believe that the media—and in particular, the entertainment industry—may be at least partially responsible for the large numbers of people who believe in astrology, ESP, alien abductions, and other forms of pseudoscience. Because not everyone who watches shows with paranormal themes perceives such fare as merely entertaining fiction, there is concern that the unchallenged manner in which some mainstream media portray paranormal activities is exacerbating the problem and contributing to the public's scientific illiteracy.[45]

In recent years, studies have been undertaken to determine whether televised depictions of paranormal events and beliefs influence television viewers' conceptions of reality (Sparks 1998). Although the results of these studies are tentative and require replication, all of them suggest that the way television presents paranormal subjects does have an effect on what viewers believe. For example,

- Those who regularly watch shows like *The X-Files*, *Unsolved Mysteries*, *Sightings*, and *Psychic Friends* were significantly more likely than those who did not watch these programs to endorse paranormal beliefs (Sparks, Nelson, and Campbell 1997).[46]
- Shows about paranormal phenomena, including UFOs, without disclaimers are more likely than those with disclaimers to foster belief in the paranormal. (Sparks, Hansen, and Shah 1994; Sparks and Pellechia 1997).
- Some fans of *The X-Files* find the show's storylines "highly plausible," and also believe that the government is currently conducting clandestine investigations similar to those depicted on the series (Evans 1996).

[41]In the 1996 Gallup Poll, 18 percent of respondents said they read an astrology column regularly.

[42]At the First Amendment Center's forum on science and the media, one of the participants cited what he called the "most frightening" results of a poll of students in Columbia's graduate school of journalism: 57 percent of the student journalists believed in ESP; 57 percent believed in dousing; 47 percent in aura reading; and 25 percent in the lost continent of Atlantis (J. Franklin cited in Hartz and Chappell 1997).

[43]In an earlier NSF survey, 6 percent of the female—compared with 3 percent of the male—respondents reported changing their behavior because of an astrology report.

[44]A survey of 1,500 first-year college students found that 48.5 percent of arts—and 33.4 percent of science—students considered both astronomy and astrology scientific (De Robertis and Delaney 1993).

[45]Examples of pseudoscience that receive a considerable amount of coverage in the mainstream media are unproven health-related therapies. Also, as Carl Sagan pointed out, almost every newspaper has an astrology column, but not many have even a weekly column devoted to science.

[46]This result could simply mean that people who believe in the paranormal are more likely than others to watch such programs. However, the findings are consistent with the conclusions of earlier experiments conducted by the same researcher (Sparks 1998).

What Is Being Done To Present the Other Side?

The Committee for the Scientific Investigation of Claims of the Paranormal (CSICOP) is a nonprofit scientific and educational organization started in 1976 by scientists (including several Nobel laureates), members of the academic community, and science writers. Members of CSICOP, frequently referred to as *skeptics*, advocate the scientific investigation of paranormal claims and the dissemination of factual information to counter those claims. CSICOP's mission includes taking advantage of opportunities to promote critical thinking, science education, and the use of reason to determine the merits of important issues.[47]

The Council for Media Integrity, an educational outreach and advocacy program of CSICOP, was established in 1996. Its objective is to promote the accurate depiction of science by the media. The Council, which includes distinguished international scientists, academics, and members of the media, believes it is necessary to counteract the entertainment industry's portrayal of paranormal phenomena because:

- ♦ television has such a pervasive impact on what people believe;
- ♦ an increasing number of shows are devoted to the paranormal, and they attract large audiences;
- ♦ a number of shows use a documentary style to promote belief in the reality of UFOs, government coverups, and alien abductions;
- ♦ opposing views are seldom heard in shows that advocate belief in the paranormal; and
- ♦ some shows contribute to scientific illiteracy by promoting unproven ideas and beliefs as real, instilling a distrust of scientists[48] and fostering misunderstanding of the methods of scientific inquiry.

To promote media responsibility—particularly within the entertainment industry—and to publicize irresponsibility—the Council established two awards[49]:

- ♦ The "Candle in the Dark Award" is given to television programs that have made a major contribution to advancing the public's understanding of science and scientific principles. The 1997 and 1998 awards went to two PBS programs: *Bill Nye—The Science Guy* and *Scientific American Frontiers*.
- ♦ The "Snuffed Candle Award" is given to television programs that impede public understanding of the methods of scientific inquiry. The 1997 and 1998 winners were Dan Akroyd, for promoting the paranormal on the show *Psi-Factor*, and Art Bell, whose radio talk-show promoted belief in UFOs and alien abductions.

In its efforts to debunk pseudoscience, the Council also urges TV producers to label documentary-type shows depicting the paranormal as either entertainment or fiction, provide the media with the names of expert spokespersons, ask U.S. newspapers to print disclaimers with horoscope columns, and use "media watchdogs" to monitor programs and encourage responsibility on the part of television producers.

Finally, various skeptics groups and renowned skeptic James Randi have long-standing offers of large sums of money to anyone who can prove a paranormal claim. Randi and members of his "2000 Club" are offering more than a million dollars. So far, no one has met the challenge.

[47]CSICOP's official journal *The Skeptical Inquirer* is a vehicle for disseminating and publicizing the results of scientific studies of paranormal claims.

[48]According to one study, scientists are portrayed more negatively than members of any other profession on prime-time entertainment shows. They are more likely to be killed or to kill someone. In fact, the study found that 10 percent of the scientists on fictional TV shows get killed and 5 percent kill someone (Gerbner 1987).

[49]The award titles were inspired by Carl Sagan's book, *The Demon Haunted World: Science as a Candle in the Dark* (Sagan 1996).

Conclusion

Americans express a high level of interest in science and technology. Despite this interest, they lack confidence in their knowledge of these subjects; in 1999, only 17 percent thought they were well informed about science and technology. Those with more years of formal education and those who have taken more courses in science and mathematics are more likely than others to express a high level of interest in science and technology and to believe that they are well informed about them.

Data on science literacy in the United States indicate that most Americans do not know a lot about science and technology. The percentage of correct responses to a battery of questions designed to assess the level of knowledge about, and understanding of, science terms and concepts has not changed appreciably in the past few years. In addition, approximately three-quarters of Americans do not understand the nature of scientific inquiry. Individuals with more years of formal schooling and who have taken more courses in science and mathematics were more likely than others to provide correct responses to the science literacy questions.

Americans have highly positive attitudes toward science and technology, strongly support the Federal Government's investment in basic research, and have high regard for the science community. However, some individuals harbor reservations, especially about technology and its effect on society. In addition, the use of nuclear energy and the use of dogs and chimpanzees in scientific research do not have widespread support. Also, a sizeable minority of the public questions the value of the space program; however, support has been gaining ground in recent years. Finally, in the past few years, new pockets of concern about genetic engineering have arisen among the well-educated and those most attentive to medical issues.

Americans get most of their information about public policy issues from television news and newspapers. There is widespread consensus—among both scientists and journalists—that important information about science and technology and their value to society is not reaching the public. In addition, the media have come under criticism, especially by scientists, for sometimes providing a distorted view of science and the scientific process, and thus contributing to scientific illiteracy.

Computers and computer technology represent a relatively new way of acquiring information, including information about science and technology. Computer usage—including access to the Internet and the use of e-mail—has skyrocketed. This phenomenon is thoroughly explored in chapter 9, "Significance of Information Technologies."

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